LEARNING SCIENCE

PART I

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PART I

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Foreword

In the planning of 10-year curriculum science has been given special importance It has been thought to be essential to provide our future citizens with a compulsory education in science up to 16 years of age. Students belonging to the age-group 11-13 have varied experience about their environment; and what is needed is to base the education of science on this experience. Such an education will equip them with proper knowledge, skill and attitudes for a better understanding of their immediate environment and will help them to play their proper role in the society of the future which is likely to be more science and technology based. This objective may be attained only if science is presented as an integrated whole. The integrated science curriculum is an effort to present such a unified approach.

The idea of integrated science is not new. From Aristotle to Einstein, a number of philosophers and scientists have spoken about the unity in the underlying principles of science. Many good teachers, through their own initiative, have presented this unity. But only in this decade serious attempts have been made to introduce this integrated approach in the school curriculum. In our country at the national level this is the pioneering effort.

A working group set up for developing this new curriculum identified the values and attitudes to be attained, and contents have been carefully selected to develop the basic cognitive abilities. The group has carefully considered the earlier experience of discipline-wise curriculum which was developed by NCERT and implemented by different states. Special consideration has been given to the kits already developed and the training already imparted for the effective implementation of the discipline-wise curriculum. Thus, to avoid complete diversion from the existing curriculum, the integration has been kept at the primary level. It is expected that a teacher, who is now handling a discipline-wise curriculum, would have no difficulty in the teaching of this integrated science. Throughout this book the activities have been designed in such a way that it becomes possible to carry them on with materials available in the immediate environment. A few items, like a magnet, that will be required are already available in the kit.

The present textbook for Class VI has been prepared within a short time. There is always scope for further improvement. Such improvements depend upon the suggestions of classroom teachers, guardians and the students. Their comments are cordially invited.

A large number of subject experts, teachers and method masters were associated

at the various stages of its development. On behalf of the Council, I thank them all. I would like to express thanks to the authors and the members of the editorial board for their enthusiasm and hard work, which has led to the completion of this task in such a short time. The authorities and the staff of Regional Research Laboratory, Hyderabad, and Indian Institute of Technology, Kanpur, deserve special thanks for extending all facilities towards the writing and editing of this book.

RAIS AHMED
Director
National Council of
Educational Research and Training

New Delhi
25 April 1977

To Our Young Readers

We are delighted to be able to give you this book. We, the authors, have enjoyed learning and doing science. We want you to share our enjoyment and pleasure That is why we wrote this book.

We hope this book will give you a lot of scope to make observations, to think, to ask questions and to do something with your hands. We have suggested many activities Of course, we do not expect you to do all of them. Do as many as you can. If you think of some activity not suggested by us, we will be very, very happy. Please let us know if you think of such activities. Our names and addresses are given in the book. You can write to any one of us.

We have given you some facts in this book. We would like you to use these facts to understand science. You do not have to memorize them.

At the end of the book, you will find a section, which gives you some additional information This is only for your interest. Please tell us if you really found this information useful and if you would like some more.

This book is not only for you but also for your family and friends. We hope you would share it with them.

We do hope you will enjoy learning science with us.

P. M. Bhargava — D. Lahiry
V. G. Kulkarni — R. Joshi
D. Balasubramanian — B. Ganguly

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This book would not have been possible without the hospitality, assistance and encouragement provided by the Director and several other members of the staff of Regional Research Laboratory, Hyderabad, where the book was written and partially revised and by the Director, Indian Institute of Technology, Kanpur, where the final revision was done.

P. M. Bhargava would like to specially acknowledge his indebtedness to his wife, Manorama, for not only helping him with the writing and revision work but also for her enormous patience and support.

V. G. Kulkarni would like to thank his wife Vijaya, who so patiently understood his absence from home for her concern for the quality of the book

Shakti and Katya understood and withstood the long absence of D. Balasubramanian at times when they needed him most at home. He thanks them for this understanding.

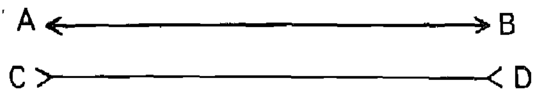
Contents

CHAPTER 1

MEASUREMENT

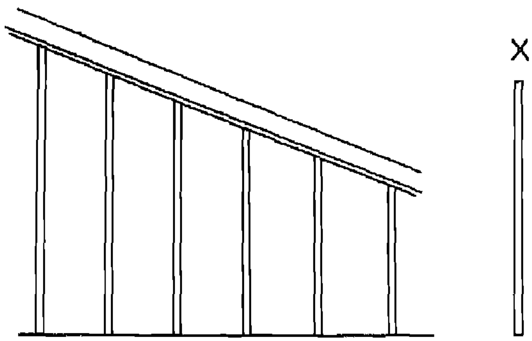
1. OBSERVATIONS

1.1 In picture **P1**, you see two lines, AB and CD. Guess which one is longer. Now measure with your scale and see if your guess is right.



PICTURE 1

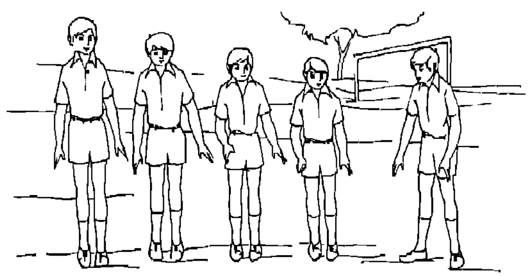
1.2 Look at the two pictures **P**2a and **P**2b.



PICTURE 2a

Here we see pillars which are part of a grill. We also have one more pillar marked **X**. Between which two pillars on the grill will you put **X**? Guess and see if you are right.

Here the children are standing in a line in a playground. Ashok has come late. Where should he stand according to his height? Guess and then verify.



PICTURE 2b

1.3 You have just made three measurements. We all make measurements in our daily life all the time. Here are some examples:

A tailor measures lengths.

A milkman measures volume.

A shopkeeper often measures weights.

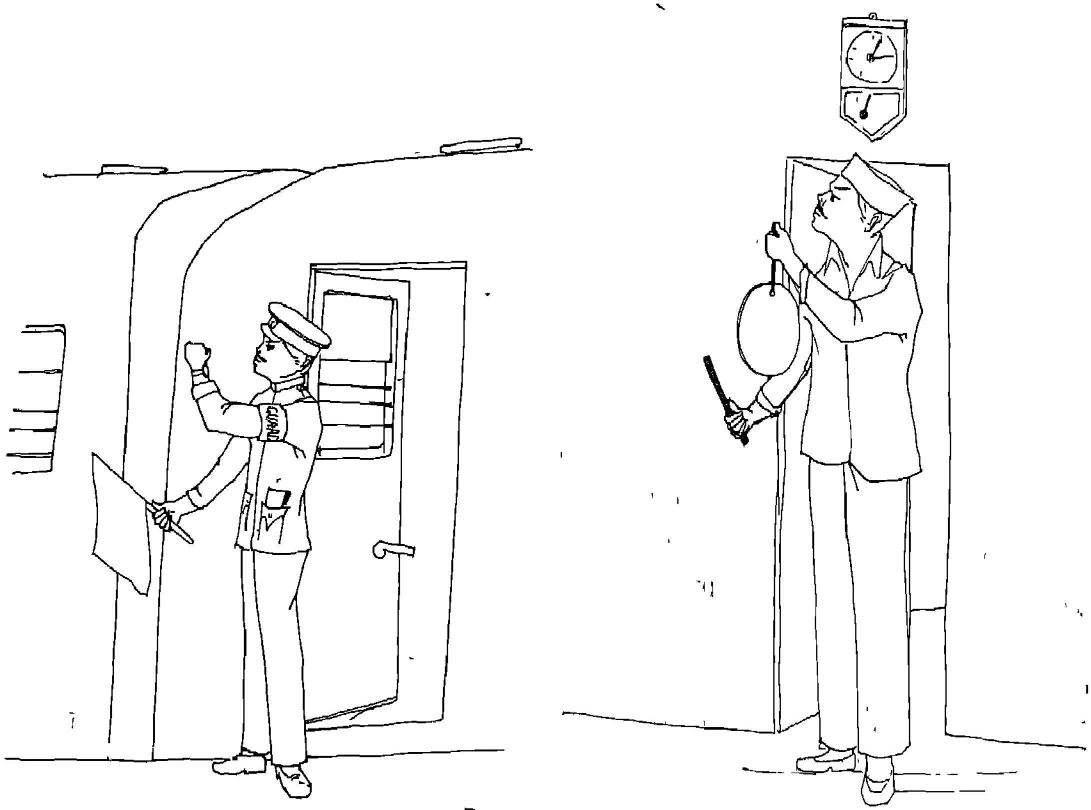
A doctor measures temperature.

A farmer measures the area of his field.

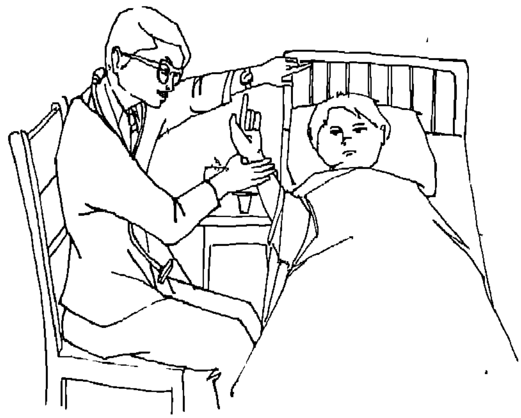
See pictures (**P**3) on next page. Do you know what these people are measuring?

Give more examples where we measure length, area, volume. weight

or time. Observe the measurements which your mother, father and other people around you make. Prepare a list of these measurements.



PICTURE 3



2. QUESTIONS

2.1 We know that some objects are long, some are short, some are big,

some are small. When we place two objects side by side, we can compare and say which one is longer or bigger. But this is not always possible. Ashok has a friend who lives in another village or city. How can you tell who is taller of the two without bringing them together? Similarly, how can you compare the length of your school bench with that of a cot in your house?

2.2 Sometimes we need to tell others what we know. If you want to tell a friend how deep your well is, or how tall your brother is, or how far your field or school is from your house, you have to **describe** these lengths. Can we do so? If so, how?

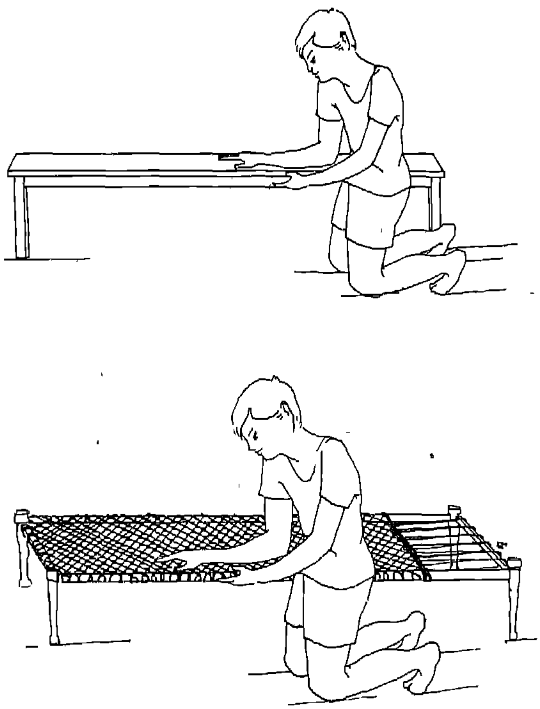
2.3 Similarly, can we describe areas, volumes, weights and time? If so, how?

3. LET US FIND OUT

3.1 We can measure in many ways

Suppose you wish to find out whether a bench in your class is shorter or longer than a cot in your house. You may not be able to move them and put them side by side. But you can move **yourself.**

Notice in these pictures (**P**4) how Ashok found the answer to the above question by moving himself. Ashok measured the length of his bench using the cubit of his hand. He found that the bench was 6 cubits long. He then went to his house and found that the cot was 7 cubits long. Does he now have the answer?



PICTURE 4

Think about what Ashok did. He did not move the cot near the bench. But he used a third object — his hand — to find the answer. He measured the bench with his hand first. Then he measured the length of the cot with the same hand. This third object, the hand, is called a *scale.* The scale does not change during measurement and is easy to move.

Ashok used here the span of his hand as the scale. Could he have used a stick, or his foot, or a thread, or anything else as a scale? Yes, indeed.

One chooses a scale according to convenience For example, if you want to measure the distance between your house and the school, what scale would you use? Your hand? Your foot? Your steps? A thread? Think about this and give the reason for your choice of the scale.

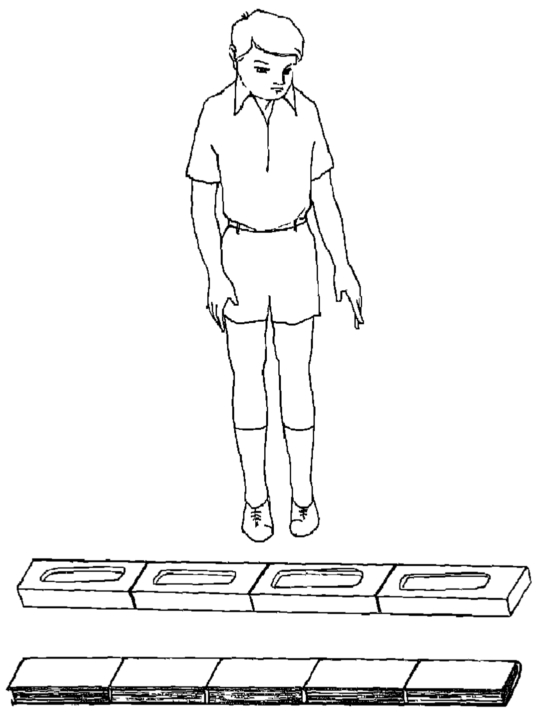
3.2 How do we tell others?

Ashok measured the bench to be 6 spans of his hand. But a smaller boy might have found it to be 7 spans of **his** hand; if the teacher measured it, he might have found it to be only 4 spans of **his** hand! Who is correct? They are all correct, but it is confusing! Why? Because each one used a different hand and therefore a different scale. If they all had used the same scale, it would not have been confusing.

Take another example. You may take 200 steps to go from your house to the school. But your younger brother may take 300 steps for the same distance. Different scales, therefore, give different answers. If both of you had used the **same** scale, say, a particular stick, to measure the distance, you would have got the same answer. In fact, any one using this stick will get the same answer. The stick is used here as a **common** scale. A common scale, therefore, removes confusion.

A **widely used** common scale is called a **standard** scale. In our country we have decided to use the **metre** as the standard scale for measuring length. Many countries in the world now use the metre as the standard scale for length. Such a widely used standard scale is known as a **unit**. Just as we have metre as the standard unit of length, we also have standard units for weight and time.

The standard unit for length is a **metre.**

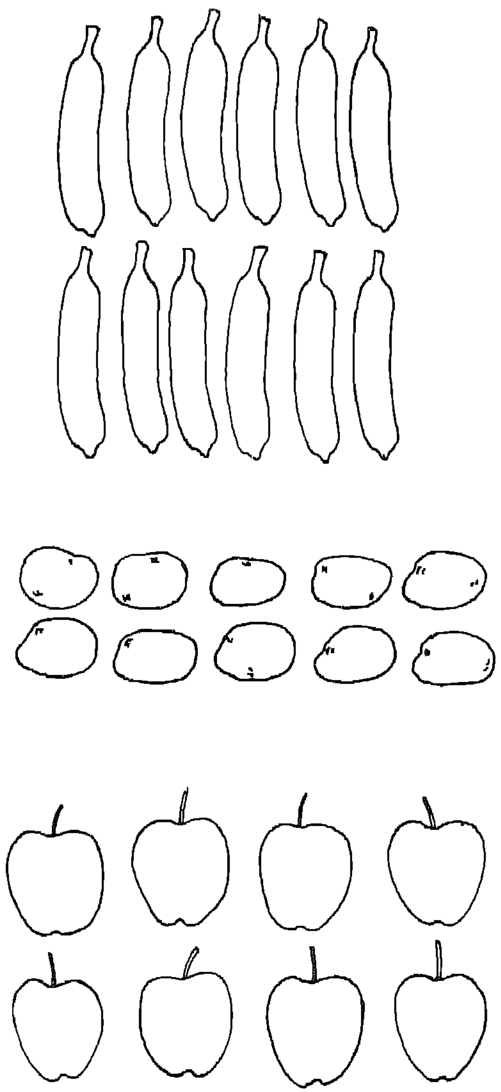


PICTURE 5

The standard unit for weight is a **kilogram.**

The standard unit for time is a **second.**

This system of units (**metre, kilogram, second**) is called the MKS system.



PICTURE 6

3.3 The MKS system

(a) Length — We have seen that length is measured in metres. How long is one metre?

the height of a 10-year-old boy.

the length of a row made by 4 bricks

the length of 5 books placed side by side.

All these lengths are nearly one metre.

(b) Weight — The standard unit for weight is a kilogram.

12 small bananas

10 medium-size potatoes

8 medium-size apples

Each of the above weighs nearly one kilogram (**P**6).

(c) Time — The standard unit for time is a second. It is a **small** unit. The time taken to say **Brahmaputra** or **Tungabhadra** is nearly one second.

3.4 Multiples and submultiples of units

As we have seen, a scale is chosen for convenience. Similarly, the unit that we use should also be convenient. The unit of money in India is a rupee. A rupee is made of 100 paise. A paisa is also a unit of money; it is a fraction, or a **submultiple**, of the rupee. We use these units according to convenience. The shopkeeper says, a kilogram of oil costs 8 rupees. He does not say 800 paise! But he says one toffee costs 10

paise; he does not say 1/10 rupee! The rupee is called the **main** unit and the paisa a fraction, or a submultiple, of this basic unit.

Take another example. Second is the basic unit of time. There are other units of time also: minute, hour, day, week, fortnight, month and year. If I ask you how old you are, how will you answer? Will you say "I am 11 years old", or "I am 132 months old", or "I am 4015 days old" or "I am 346896000 seconds old"? If you say, "I am 11 years old", you are using a **multiple** of the basic unit of time. You do so because it is convenient. Thus, besides the basic units, there are other units of length, weight and time. We use these multiple or submultiple units depending on our convenience. In Table 1, we give the various units.

3.5 Area

We often make statements, such as, "My house is spacious", or "This room is too small", or "Our playground is big." When we use such phrases, what **exactly** are we trying to say? Let us find out.

Using a graph paper, cut about one hundred squares, each of them 1 cm long and 1 cm wide. Draw in your notebook two rectangles, A and B.

Rectangle A

7 cm long and 2 cm wide

Rectangle B

6 cm long and 8 cm wide

Which of these rectangles is bigger? You will notice that this question is similar to the question "Is the playground of my school bigger than that of Ashok's school"? Now use the squares you have cut, to cover

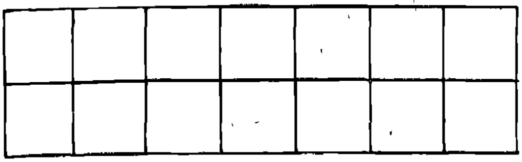
TABLE 1

Units of Length, Weight and Time

(Basic units are given in bold letters. The short forms of writing the units are given in brackets.)

Length		**Weight**
10 millimetres (mm)	= 1 centimetre (cm)	1000 milligrams (mg) = 1 gram (g)
100 cm	= 1 **metre** (m)	1000 g = 1 **kilogram** (kg)
1000 m	= 1 kilometre (km)	100 kg = 1 quintal
		10 quintals = 1 metric ton = 1 tonne (t)
	Time	
60 **seconds** (s)	= 1 minute (min)	365 days = 1 year
60 min	= 1 hour (h)	10 years = 1 decade
24 h	= 1 day	10 decades = 1 century

the two rectangles completely. How many squares do you need to cover rectangle A(P7 a) and how many to cover rectangle B? (See P7b) When we start



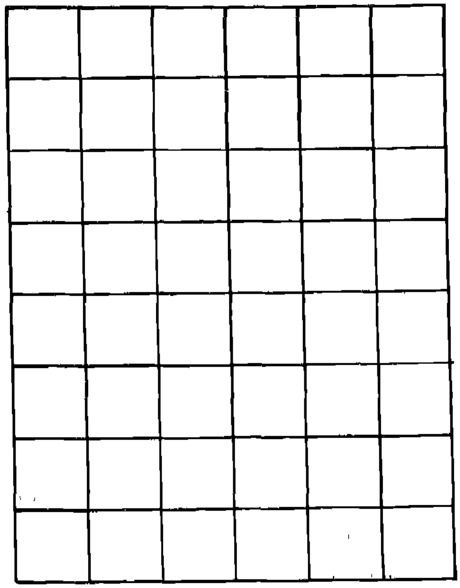
PICTURE 7a: Rectangle A

covering rectangle A, say, from the right-hand top corner, we place 7 squares in a row. Then we come to the boundary. So we start another row. You would find that we need 2 such rows to cover the whole rectangle.

Hence we need $7 \times 2 = 14$ squares to cover rectangle A For rectangle B, we would find that we can place 6 squares in a row and that we need 8 such rows. We, therefore, need $6 \times 8 = 48$ squares to cover rectangle B.

As we need 48 squares to cover rectangle B but only 14 squares to cover rectangle A, we can say rectangle B is bigger than rectangle A.

Do we have to repeat this exercise every time we are asked a similar question? Would it not be enough if we simply multiplied the length and the breadth? Draw two more rectangles: rectangle C, 6 cm long and 6 cm wide; and rectangle D, 9 cm long and 3 cm wide. Now check what we have said



PICTURE 7b Rectangle B

above. You will find that rectangle C will need $6 \times 6 = 36$ squares to cover it up, while rectangle D will need only $9 \times 3 = 27$ squares.

When we use terms like small, spacious or big to describe places like a room or a playground, we are referring to the **area** of these places.

We need to measure two lengths and then to multiply them to get the area. Area of a rectangle is the product of two lengths. The unit of area is metre $\times$ metre, that is metre^2 (m^2). 10000 m^2 make one hectare. This unit is used to measure large areas such as fields. $1000 \text{ m} \times 1000 \text{ m} = 1000000 \text{ m}^2 = 1$ kilometre^2. The areas of countries are expressed in kilometre^2.

3.6 Volume

We often say:

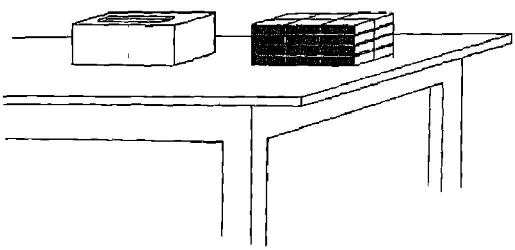
- a brick is bigger than a match box;
- my cow gives more milk than yours;
- a bucket holds more water than a cup.

What do we mean by these statements?

When we say "more milk", or "more water", we are actually referring to the **volumes** of milk and water. Similarly, when we say the brick is bigger, we mean that its volume is larger. How can we **measure** volumes? Let us do the experiment shown in **P**8.

Keep the brick on the table. Now, using match boxes, build a pile which will look like the brick in size and in shape. First find out how many match boxes are needed to cover the top surface of the brick.

Now lay the match boxes side by side and make the base This formation does not look like the brick because the height is too small. Put another layer of match boxes on top of the first layer. Repeat this step until you are satisfied that the pile looks as big as the brick.



PICTURE 8

You will find that each layer needs $2 \times 3 = 6$ match boxes and that you need 4 such layers to make the brick-like pile. In other words, you need $2 \times 3 \times 4 = 24$ match boxes. Note that the number 24 is a product of three numbers. Therefore, to measure the volume of a brick-like object, we have to measure **three** lengths: two lengths for the area of one face and the third for the height of the object Volume is thus the product of three lengths.

The volume of liquids and gases is measured in litres (l). Five to six cups of milk will make nearly one litre. A commonly used submultiple of a litre is a millilitre (ml). The volume of solids is measured in cubic metres ($m \times m \times m = m^3$) or cubic centimetres ($cm^3$).

$$1000\ ml = 1\ l$$

3.7 Length is a basic quantity

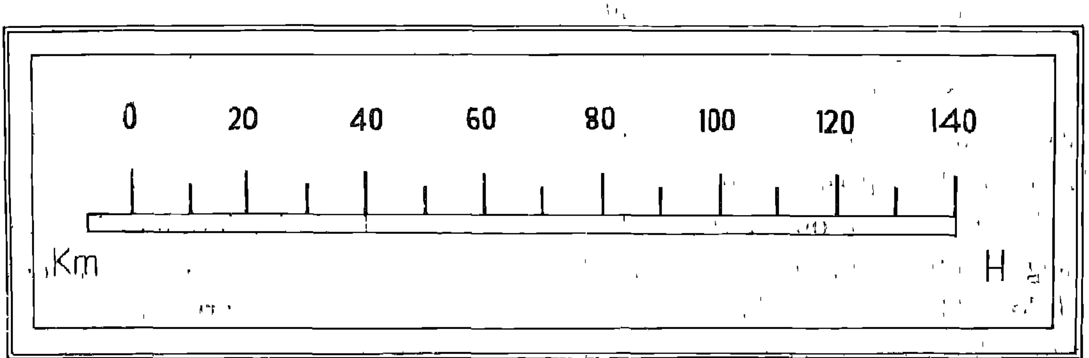
We have learnt to use a standard unit for measuring length. We can measure the length of any object by comparing it with this standard. We have also seen that area is the product of two lengths, and volume is the product of three lengths. You will find

that length is an important **basic** quantity and that a very large number of measurements are made in terms of some length. For example,

(*a*) When we use the thermometer to measure temperature, we are measuring a length. Do you see how?

(*b*) When we use a spring balance (which we shall study later) to measure weight, we are measuring the length of a spring.

(*c*) Some Fiat cars have a rectangular speedometer which tells you how fast the car is going (**P**9). Here we measure how far the pointer has moved in one direction — that is, a length.



PICTURE 9

Can you think of other such examples?

3.8 Estimation and measurement

In our daily life, we often have to make a quick judgement or decision about measurement, with only our senses to help us!

When you play *gully-danda*, you estimate how far you have hit the *gully*. You estimate this length in terms of the *danda*. If you estimate wrongly, you may lose the game.

If you wish to bring 5 kilograms of potatoes, you must know which sack to carry to the bazaar.

Similarly, we may have to guess:

— how many bricks we need to build a wall;

— how many tiles we need to cover the roof;

— how much fertiliser we should buy for our field.

Sometimes, tradesmen buy a whole crop of, say, mangoes in a grove. They estimate how many mangoes they would get from the grove and then bid the price. If they guess wrongly they would lose money. If the person selling the mangoes estimates his crop wrongly he might sell it too cheap. Both the

buyer and the seller here need the skill of estimation.

You want to go to the cinema or theatre 1 km away. You can walk to the theatre in 20 minutes, or you can take a bus. But at the bus-stop there is a queue of 50 people. You want to reach the theatre as early as possible. What will you do? Walk or wait for the bus? To decide, you will estimate time.

It is, therefore, useful to be able to estimate correctly. What do we do when we estimate?

When we make estimates we use only our senses. We recall from memory similar experiences in the past. We make a comparison and then arrive at a decision. Estimation is, therefore, a comparison, just as measurement is. Is estimation as reliable as measurement? Obviously not. Looking at a heap of potatoes, you can estimate whether they will weigh 5 kilograms or 10 kilograms, but can you tell whether they will weigh 10 kg or 11 kg? Probably not!

Estimation is a skill. You can improve your skill by practice. So, practice making estimates, and check your estimates by actual measurements.

3.9 Accuracy in measurement

How accurate do we need to be when we measure? Let us look around and see.

A tailor measures length. If he makes a mistake of one or two millimetres, the clothes will still fit. If, however, a carpenter makes a mistake of one or two millimetres, things may not fit. In making parts of a machine (such as ball bearings), accuracy up to a very small part of a millimetre is needed. When we measure temperature, we measure the length of a mercury column in a thermometer. A difference of 3 cm in this length will decide whether you are healthy or very very ill. A mistake of 3 cm in measuring the length of a field would not matter.

Similarly, when we weigh coal or wheat, we do not need very high accuracy; neither you nor the shopkeeper is likely to be worried if you have received a few grams more or less. When we weigh cloves (*laung*) or cardamom (*ilaichi*) we try to be accurate to one-tenth of a gram. Even greater accuracy is needed when we weigh gold or silver.

When we prepare dishes in the kitchen, ingredients such as salt, pepper and other spices are added by estimation. In the preparation of medicines, it is important that the ingredients are measured very accurately.

Milk or kerosene is measured rather quickly and roughly. It does not pay to worry about a few drops. When you measure perfume, every drop counts!

The accuracy in measurement, therefore, depends upon the need and the value of the material. We tell our age in years, not in years, months, days and minutes! When we go to see someone or wish to catch a train, we need to be punctual to the minute. In Olympic races, the time is recorded accurately in fractions of a second to decide the winner and to find out if a world record has been broken. If we start measuring perfume as we measure kerosene, or if we go to the railway station without being punctual, we will suffer. Similarly, if a tailor starts making measurements as accurately as a ball-bearing manufacturer does, he will be wasting his time, energy and our money!

3.10 The colloquial measurements

You will find that we often use phrases like, "The water in this well is two-men deep", or, "My house is within one shout from the bus stand", or, "The railway station is within walking distance from my house". These phrases are not wrong. In fact, they are useful. They give a rough idea of length or distance. If, however, we wish to be more accurate and to be understood by everybody, we should express measurements in standard units.

3.11 The need for multiple measurements

In our daily life we often need more than one measurement to make a decision. Thus, when we buy tomatoes we weigh them and also find out if they are ripe and of good quality. When we buy cloth we measure length but we also often estimate softness, texture and other qualities. In deciding the price for a piece of land, we need to know many things about the land: for example, its area, the richness and the depth of its soil, its location and its distance from the source of water. The doctor usually measures temperature and the pulse rate, but he also often examines the tongue, the eyes and several other parts of the body.

3.12 How are standards kept?

We have seen that we need standard units for reliable measurement. Where can we obtain these standards from?

We can get the correct time from the radio. All India Radio (*Akashwani*) announces the correct time from all its stations several times a day. We can buy standard measures of length (such as a tape or a metre rule) as well as

standard measures of weight (such as a kilogram or a gram weight) from the market. Most states in our country have Departments of Weights and Measures. These will help you obtain standard measures of weight and length.

Shopkeepers use standard measures like the metre, the litre, and the kilogram. Government officers, called Inspectors of Weights and Measures, inspect these shops regularly to make sure that these standards are correct.

If you suspect that someone is using a faulty standard, you should complain to the nearest police station. If you do not complain, you as well as others will suffer. And if you are a shopkeeper yourself, you are obliged to keep proper standards and to get them checked regularly.

4. ACTIVITIES

4.1 If you play the *gully-danda* game, try to guess the distance when the *gully* has been hit, in terms of the *danda* and verify your guess.

You may also try to estimate in metres the lengths given below; in each case, check your estimate by actual measurement.

(i) The length and the breadth of your classroom.
(ii) The height of the doors and of the windows in the classroom.
(iii) The height of a friend.
(iv) The length of your shadow in the morning, at noon and in the evening.

4.2 Using a sheet of graph paper, find out the areas of some leaves of the trees around you. To do so, place the leaf on the graph paper. Draw the outline in pencil. Count the number of squares within the outline of the leaf. If half or more than half of a square is within the outline, count it as one; if less than half is in, omit it. You may use the same method to find out the area of other irregular objects. Compare the measured value in each case with your estimate.

4.3 Make a simple pan balance and use it to measure the weights of a few objects, using marbles or nut-bolts as standards.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Scales and standards

We have seen that measurements are an inseparable part of our daily life; it is often necessary for us to make measurements of length, weight and time. All measurements are comparison of a particular property of an object with the same property of a standard.

We have a choice of a large number of standard measures. If, however, we wish to communicate with others, the standard measure we choose should not vary from person to person, from place to place, and from time to time. As communication between countries has now increased enormously, it would be advantageous if the standard does not vary from country to country as well.

We have learnt that India, along with many other countries of the world, has adopted the MKS system of units for all types of measurement. In the MKS system, metre, kilogram and second are the basic units for length, weight and time respectively. We often use, for convenience, multiples and submultiples of these basic units.

5.2 Estimation is useful

Estimation is rough "measurement" by our senses. It is useful and can often help us. We should, therefore, learn to estimate so that our estimations are reliable. The skill of estimation improves with practice. The ability to make a good estimate will help you in planning your work and in being punctual.

5.3 Multiple measurements

In daily life we are often required to make **several** measurements before taking a decision. We often find that the larger the number of measurements and more carefully they are made, the better is the decision. For example, a good doctor makes many measurements before deciding which medicine to prescribe.

5.4 Our responsibility

For a measurement to be correct, the standard used must be correct. It is important not only for us but also for others – and for the country – that the measurements made are correct. We should, therefore, acquaint ourselves from where we can obtain correct standard measures. It is our responsibility to ensure that only the correct standard measures are used by people around us.

CHAPTER 2

MATERIALS AROUND US

1. OBSERVATIONS

1.1 We see a variety of materials and objects around us Sand, water, glass, wood, plastic and copper are some materials we know. A chair, a glass tumbler, a plastic comb and a copper kettle are objects made from some of these materials. All objects are made of one or more materials.

Some materials and objects are natural, such as water, wood, sand, rocks and plants. Some are man-made, such as glass, a cup and a chair.

Some are living, such as you, a cow and a wheat plant. Some are not living, such as your photograph, milk and a piece of bread or a chapati.

Some are visible, such as smoke. Some are not, such as air.

Some flow, such as water, oil and kerosene. Some do not flow, such as rocks and books.

Some are transparent, such as glass, air and water. Some are opaque, like the blackboard, chalk pieces and bricks

Some are solid, such as sugar, ice and hammer. Some are liquid, such as water, oil and milk. Some are gases, like air and steam.

The above are examples of objects on earth. There are also objects in the sky, such as the moon, the sun and the stars.

1.2 We have grouped objects and materials above in different ways, like living and non-living, or transparent and opaque. You will enjoy finding other ways of grouping objects; for example, those that break easily, such as glass and chalk pieces and those that do not break easily, such as a rock.

When you have prepared a number of such groups, try to answer the following two questions:

(a) Are there items that you can put in both the groups? For example, ice is made by man, and it is also made naturally in a hailstorm. Try to find more of such examples.

(b) Are there items which will not fit in any of the groups? For

example, are there objects which are neither living nor non-living?

A few objects are listed below. Where would you put them in the groups we have made above? Check whether your friends agree with your decision.

Glue	Mirror	Curd
Wheat grain	Rubber	Mango seed

1.3 You will find that grouping objects as solids, liquids and gases is specially useful.

2. QUESTIONS

2.1 Why did we say that grouping objects and materials as solids, liquids and gases is specially useful?

2.2 What properties do all solids have in common?

2.3 What properties do all liquids have in common?

2.4 What properties do all gases have in common?

2.5 How is one solid different from another, one liquid different from another, and one gas different from another?

2.6 Are there any properties shared by all objects and materials?

2.7 What are various objects and materials made of?

3. LET US FIND OUT

3.1 Solids, liquids and gases

We find it useful to group objects and materials as solids, liquids and gases because there are **many** important and interesting differences between the three groups. Let us list some of these differences:

(**a**) Can you heap a solid? Try with **any** solid you like. The answer is 'yes'. Can you heap a liquid or a gas? Try with water or smoke. The answer is 'no'. Here is a difference between solids on one side and liquids and gases on the other. You can heap a solid, but not a liquid or a gas.

(**b**) Can you scratch a solid? Try scratching a stone or a piece of wood with a nail? The answer is 'yes'. Can you put a scratch mark on a liquid or a gas? Try doing so on water or air. The answer is 'no'. Here is a second

difference between solids and liquids or gases: one can scratch solids but not liquids or gases.

(**c**) We tried to make a heap of water. We could not, because water flowed away. You will observe that all liquids and gases flow. Solids do not. Here we have a third difference between solids and liquids or gases.

(**d**) What happens when you put salt or sugar in water? The salt or sugar 'disappears' into the water—that is, it dissolves. Similarly, we often see smoke or steam (both of which are gases) disappearing into air (another gas). Soda water is prepared by dissolving a gas called carbon dioxide in water. When you open a soda-water bottle, you see bubbles coming out. They are caused by the escaping dissolved gas. Spirit dissolves in water; so does glue. In general, liquids and gases can act as 'solvents' into which other substances seem to 'disappear'. But solids do not ordinarily dissolve in other solids. Here is another important difference between solids and liquids.

(**e**) How do you store liquids? In a vessel, of course. If you remove the lid does the liquid flow away? No. Have you ever stored a gas? You have indeed done so if you have ever filled air in a balloon or in a football or a bicycle tube! What will happen if you open an inflated balloon, football or bicycle tube? The air will rush out. Can you now say whether or not we can store a gas in an open container? (Try storing smoke in a glass or a bottle without a lid.) Here is one more important difference between liquids and gases. Liquids can be stored in an open container, but gases can be stored only in a closed container.

(**f**) If you light an *agarbatti* in a corner of a room, you can soon smell it all over the room. The smoke from the *agarbatti* spreads all round the room. Now fill a small bottle with smoke. You can do so easily by holding the bottle over the glowing tip of the *agarbatti*. When the bottle is full of smoke. remove the *agarbatti* and quickly close the bottle with your thumb. Now put the bottle in a glass tumbler, remove your thumb and quickly cover the glass with a book. You will see the smoke from the bottle coming out into the glass; it will finally fill the whole glass. Repeat the experiment using water instead of smoke. The water in the bottle does **not** come out and fill the glass. Liquids do not spread all over the container, while gases fill all the available space. This is another difference between liquids and gases.

Do you see any relationship between the properties mentioned in **d**, and **f** ?

3.2 Solids

List as many solids as you can. For example:

25 and 50 paise coins	A plastic vessel
Iron wire	Coal
A spring	A hen's egg
A flower	Dough
Sugar	Candle wax
Cotton	Wood
Plasticine	Common salt
Silver	*Kalai*
Sulphur	Porcelain
Copper	A butterfly
An earthen pot	Butter
Asafoetida	Paper
Camphor	Mud
A naphthalene ball	Ice
Bleaching powder	Solidified coconut oil
Rubber	Saffron
Glass	Solder
Wool	Soft wax
	A steel vessel

Add more solid objects to this list.

You will notice that different solids have different properties. For example, some solids are very hard, like steel. Some are very soft, like butter. Some are in between, like wool.

Some solids are colourless; some are heavily coloured.

Some solids are stretchable; some are not. Some solids are **plastic**, that is, their shape can be changed easily. In the case of many other solids it is difficult to change their shape.

Some solids melt easily; some melt at a high temperature.

Some solids can be beaten into very thin sheets; others not.

Some solids can be drawn into very thin wires; for others this is very difficult.

Some solids float in water, others do not.

Some solids dissolve in water, others do not.

Some solids conduct heat well, others do not.

Some solids conduct electricity well, some do not.

Some solids can catch fire, others cannot.

Some solids are magnetic, that is, you can make a magnet out of them; others are not.

Some solids smell, others do not.

Some solids are living, others are not! (Do you agree!)

From the list given above, and the list you have made, find examples of all the above groups.

3.3 Liquids and gases

List as many liquids as you can, as we did for solids.

You will note that some liquids are colourless, some are coloured. Some liquids flow easily, some do not.

Some liquids appear **thick**, others

ıids do not smell, others

iquids can dıssolve like sugar, salt or paint; dissolve them.

uıds solidıfy (that ıs, others do not solidify so

quids catch fire easily, some can, therefore, be used to ..e.

: liquids boil easily, some boil / high temperatures.

.an you name liquids belonging to ı of the above groups, out of the you made?

Just as a solid differs from other olids and a liquid from other liquids, a s also dıffers from other gases in me properties. Some gases (like the *;arbatti* smoke) smell, while some ..hers (like air) do not. Some gases (like steam) easily become liquid (water), but some others (like air) do not do so easily. Some gases catch fire easily, while some others do not. Can you give examples?

3.4 Elements

We have now studied a large number of objects and materials. We found that there were many differences between them, and we could group them in a variety of ways. If you observe the details you will find that all of them have some **common** propertıes too. For example, they have some weight and they **all** occupy space.

If you look around, you would find a great deal of variety in objects and materials. There are many kinds of plants and animals, many kinds of stones, and different types of soil. If you look at two mango trees, you will notice that they are not quite identical. No two human beings are exactly alike. How is all this variety generated? What are all the objects and materials around us made of?

To answer these questions, let us recall some of our experiences.

(a) We draw pictures and we can paint them in a variety of colours. How do we obtain such a variety of colours?

All colours can be obtained from just three basic colours — red, yellow and blue — by using different combinations of these colours.

(b) The number of words and sentences we know is very large. We also know that there is a great variety

All written materıal in English uses only 26 letters of the alphabet. All the words and sentences that go into

of literature that exists and that can be produced. How is this variety obtained?	producing such a variety of literature, are obtained by using different combinations of these 26 letters.
(c) We know many songs set to so many different tunes. How do we obtain so much variety in music?	All music uses only a few basic notes. The variety in music is obtained by using different combinations of these notes.

In all the above examples we notice that an enormous variety can be produced by combining a small number of basic building blocks in different ways.

If you look around, you will find many more such examples. Your mother uses only a few materials to cook such a large number of dishes!

Is it likely that the innumerable objects and materials we see around us or we know of, could also be made of just **a few** building blocks? In fact, we now do know that there are only about a hundred basic building blocks **out of which all objects and materials in the universe are made**. These building blocks are called **elements**.

Carbon, oxygen, aluminium, iron, silver and gold are some common elements you know of. Calcium, phosphorus, sodium, mercury, hydrogen and nitrogen are some others. Only about 40 elements are found **commonly**. The others are rare.

3.5 Atoms and molecules make elements and compounds

We have said that there are about 100 elements in the universe. What is each element itself made of? Scientists have found that each element is made of very small particles called atoms of that element. A piece of silver is made of silver atoms, a piece of copper is made of copper atoms, and so on. An atom is an extremely tiny particle and cannot be seen with the naked eye—or even with a powerful microscope. One milligram of silver contains about 6 billion silver atoms!

All atoms of any one element are alike, but atoms of one element differ from the atoms of another. Thus, there are 100 or so different kinds of atoms that go to make the 100 or so different elements we find in nature.

Quite often, atoms of the same element, or of different elements come together and get attached to each other. This attachment, called a

reaction, produces a new particle called a **molecule**. Molecules, therefore, are made up of atoms of the same element or of different elements.

For example, two hydrogen atoms react to produce one hydrogen molecule. The element hydrogen is thus made up of hydrogen molecules. Silver atoms do not react easily with each other; the element silver is, therefore, made up of silver atoms. Thus, some elements are made up of atoms; while others are actually made up of molecules of their atoms.

Let us now take an example of a molecule made up of atoms of different elements. When two atoms of hydrogen react with one atom of oxygen, we obtain one molecule of water. When atoms react—that is, come together to make molecules, the atoms lose some of their original properties and acquire new properties. For example, hydrogen by itself is explosive and oxygen supports fire; but when atoms of hydrogen and oxygen react to form molecules of water, the water formed is neither explosive nor does it support fire.

When many identical atoms—or molecules made up of identical atoms—come together, we obtain an element. Similarly, when many identical molecules made up of **more than one type of atom** come together, we obtain a **compound**. We cannot see atoms or molecules, but we can see elements and compounds.

The variety that we see in the materials and in the objects around us is possible only because elements can react with each other in very many different ways to produce many different compounds.

In many materials, atoms or molecules of two or more elements or compounds are mixed—somewhat like the spades, clubs, diamonds and hearts in a shuffled pack of cards. These atoms and molecules are simply **packed together:** there is no reaction occurrring between them. Such materials are called **mixtures**. Air is a mixture of oxygen, nitrogen, and several other gases like neon which is used in neon lights.

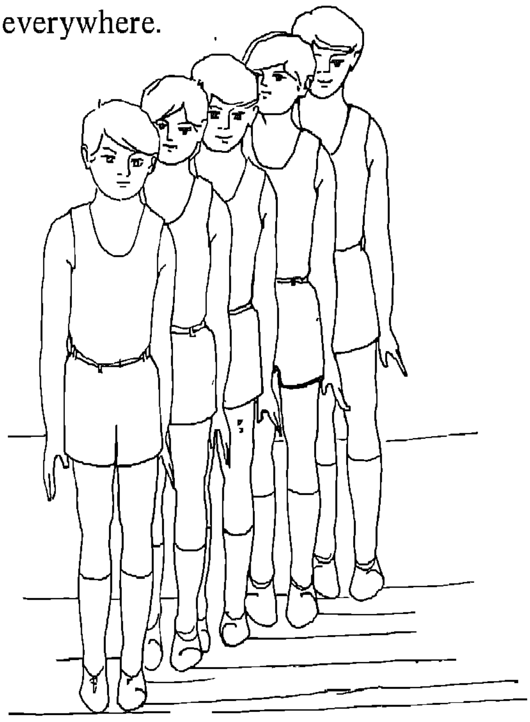
All objects and materials, whether living or non-living, whether found on earth or anywhere else in the universe, are made of one or more of the hundred and odd elements. All objects and materials — **without any exception** — are, therefore, elements or compounds, or mixtures of elements and compounds and nothing more.

3.6 Packing of atoms and molecules

There are three main **styles of packing** of atoms and molecules in elements and compounds:

I	II	III
The atoms or molecules are close to one another, each one attracting its nearest neighbours rather strongly. There is very little freedom to move around	The atoms or molecules are not so closely packed The attraction between the atoms or molecules is **not so strong** as in case I. They can, therefore, move around a bit, but not **too much**	The packing of the atoms or molecules is so little and so loose that we can ignore it. Each atom or molecule is on its own, that is, free to move in all directions

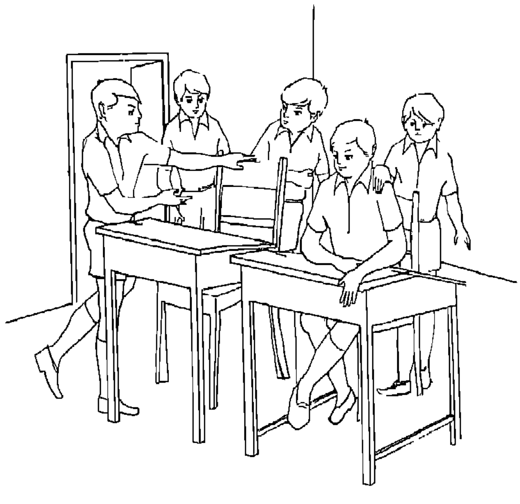
Can you guess the common names of these three styles of packing? Yes, I is a solid, II is a liquid, and III is a gas. We can now understand better why solids are hard and rigid (that is, they do not flow), whereas liquids flow but do not fly off, and gases spread everywhere.



PICTURE 1a

We can get an idea of the three styles of packing of atoms and molecules if we compare:

—Atoms and molecules in a solid to pupils of a class standing in lines at attention on a drill ground;



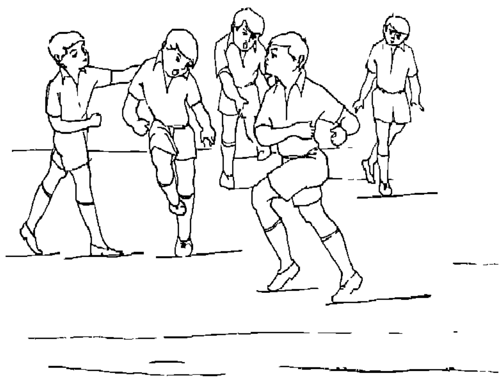
PICTURE 1b

—Atoms and molecules in a liquid to pupils in a class during a recess between periods; they can move around but cannot leave the class.

—Atoms and molecules in a gas to

pupils left to themselves on a large playground.

Notice in pictures P1a. b, c that there is space between the pupils in all the three cases. Similarly, there is space between atoms or molecules in solids, liquids and gases.



PICTURE 1c

4. ACTIVITIES

4.1 Collect as many objects as possible and group them in any manner you like. Compare your method of grouping with the methods used by your friends. Find out the advantages and disadvantages of each method of grouping used.

4.2 Use the balance you made earlier to show that air has weight. The teacher will show you how to do this experiment.

4.3 Find out the volume of one grain of wheat by putting a large number (say 500 grains of wheat) in a measured volume of water and noting the increase in the volume of water.

4.4 Can you use a similar method to find out the thickness of one sheet of your book?

4.5 Design an experiment to show that no two objects can occupy the same space.

4.6 Heat the following materials and objects, and record **all** changes: butter, wax, glass, an iron nail, wood, paper, a seed, sugar, rubber, sand, ice, water, and any other substance you can think of. In order to avoid accidents, consult your teacher before you do this experiment.

4.7 Use plastic material to make a model of any object you like.

4.8 Collect the following materials and objects: sand, an iron nail, a small stone, a piece of soft wood, a slate and a burnt out matchstick. Try to scratch them with one another. Does this experiment enable you to arrange these

materials and objects in the order of increasing hardness?

4.9 Collect the following objects: a small stone, a nut-bolt, a bird feather, a piece of ice, a cork, a bowl, a plastic mug, a piece of wood and a sheet of paper. Check which of these objects float on water and which sink.

Can you observe any differences in the way objects float? List as many differences as you can.

See what happens when the floating plastic mug and metal bowl are filled with water.

Try to make a needle float on water!

Ice floats on water. See if it floats on kerosene.

Pour some kerosene in a glass vessel half filled with water. Notice that the two liquids do not mix and can be seen separately. Put a piece of ice in this vessel. See where it stands. Now pour some kerosene in another glass vessel half filled with spirit and wait for a few minutes. In the latter case, you will see that the two liquids mix with each other and cannot be seen separately. Put a piece of ice in this mixture and see where it stands.

4.10 Collect six lids (or caps) of bottles. Try to pile as much of the following materials on them as you can – one material on one lid – without the material spilling out of the lid: water, sand, glue, honey, molten wax and chalk powder. Does this experiment enable you to arrange these materials in the order of their ability to flow?

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 What are objects made of?

All objects are made of one material or another (for example, a glass tumbler is an object made of the material glass). All materials in the universe are made up of elements and compounds. There are about 100 elements in the universe and each element is made up of its atoms. Atoms combine to produce molecules. Compounds consist of molecules made up of different types of atoms. The properties of any material are due to the properties of the elements and the compounds of which it is made of. We have seen that we can classify materials on the basis of their properties.

5.2 The use of materials

Man has always been discovering and inventing new materials and new

uses of known materials. Many of these discoveries have been important steps in the progress of man. For example, thousands of years ago, man did not know how he could use stone. But soon he found out how to make tools of stone. He then made knives, axes and huts from stone. These new uses of stone made life more comfortable for him, and made him prosperous. This period in the history of man is called the 'Stone Age' Soon afterwards, man discovered metals like bronze, copper and iron. These metals could be used for many more purposes than stone.

Life became easier and more prosperous every time man discovered new materials or new uses of existing materials. Had coal, oil and aluminium not been discovered, we would have had no railways, buses and aeroplanes.

Today, we use an enormous variety of materials in our everyday life—at home and at work. Materials such as fertilisers, help us grow more foodgrains. Materials like cement, concrete and tar, help us build better, stronger and more durable houses and roads.

Only 50 years ago, lakhs of people in India died of smallpox. Then, doctors found out that a material called smallpox **vaccine** can be used to prevent the disease. We now use this vaccine in every village. You yourself have been vaccinated. Every man, woman and child in our country is now vaccinated from time to time. This year, therefore, not even one person suffered from smallpox in India! Similarly, diseases like typhoid and tuberculosis, for which there was no cure when your grandfather was your age, can now be cured by newly discovered medicines.

Man has also been **inventing** new materials that did not exist before. Plastics, nylon and transistors are examples of such materials invented in the last 50 years. You know how useful they are. For example, until the transistor was invented only rich people could afford radios. The transistor radio is inexpensive and small enough to be carried anywhere. These days, **many** of us can listen to news, weather broadcasts and even running commentaries on games played anywhere in the world.

Try making a list of objects and materials which:

— save you labour (for example,a tractor)

— save you time (for example, a bicycle)

— help you learn more and faster (for example, books)

— help you keep good health (for example, penicillin)

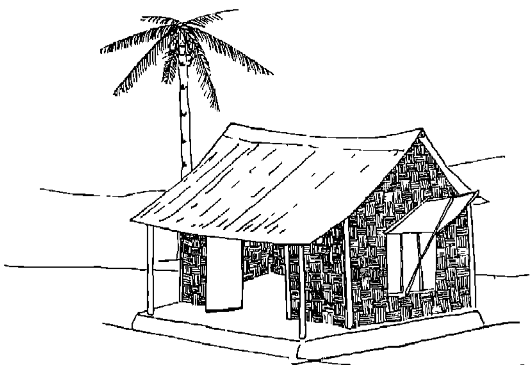
— protect you from bad weather (for example, umbrella).

Since the supply of most materials and of objects made from them is limited, we should learn to use the materials and objects available to us properly, carefully and only when we need them; **we should never waste materials.**

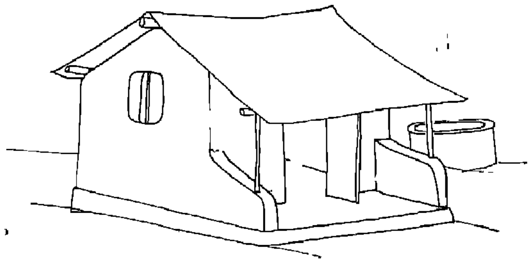
5.3 How should we choose materials and objects for everyday use?

(**a**) What we choose must be suitable for our need. You cannot use a paper bag to carry 20 kilograms of rice! You would have to use something stronger, say, a tin can or a thick cloth sack. Similarly, if we wish to drink hot tea, we should use a cup made of a material like china clay, which is a poor conductor of heat We should not use brass vessels to store sour materials like butter milk or pickles. Sour materials dissolve a little bit of the brass—and brass is bad for health when eaten.

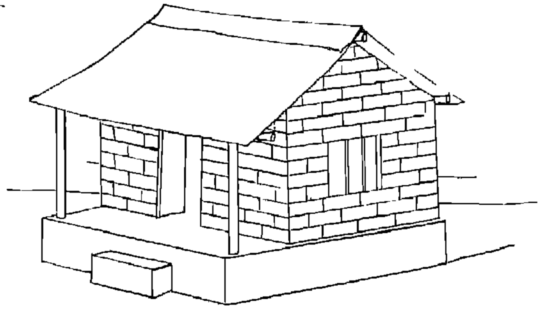
(**b**) We should use materials and objects which are inexpensive and easily available nearby. It is wise to use bricks to build a house where bricks are cheap and easily available. In the coastal regions of our country people wisely use parts of the coconut tree, and in many other places, mud and bamboo to build houses. These materials are easily available there and are cheap. They also serve the purpose well.



PICTURE 2a



PICTURE 2b



PICTURE 2c

Some fruits and vegetables are cheap and available in plenty in some seasons. During this time, we should use these fruits and vegetabels instead of the expensive ones. In North India, you may have seen cups made of clay; they are called *kullarhs*. Here is an example of a wise use of cheap and easily available material. In our country a *kullarh* is usually more hygienic than a cup made of any other material. (Can you say why?).

(**c**) Materials and objects that last long and are convenient to use should be preferred to those that break or wear out easily, or are cumbersome. Plastic vessels are cheap and can be often used in place of glass. Cloth made from man-made fibres like nylon, terylene or terycot, can be easily washed, needs very little ironing and lasts longer. It, however, does not absorb sweat as well as cotton does. In Western countries (i) man-made fibres are produced very cheaply; (ii) cotton is not grown extensively and (iii) people do not perspire much. The clothes made out of man-made fibres are, therefore, suitable there. Such fibres are not ideal for our country, because (i) they are expensive to produce; (ii) cotton is grown extensively and (iii) people perspire a great deal.

(**d**) Materials and objects should be used where they are required most. Our house is not the only place where they are required. The country may need the same materials that we use in the house, for a variety of other important purposes. For example, copper is used for transporting electricity to our villages and cities. Our country has only a small supply of copper. It would, therefore, be wise to use a GI bucket or drum for storing water in the house and let the country use copper for other purposes.

Wood is another such material. Wood is used for many purposes, such as cooking and building boats, houses and furniture. We obtain most of the wood from trees in our forests. If we all use wood as fuel (that is, as firewood), very soon all our jungles will be gone and our country will become barren. As we will see later, man cannot live without plants. Well, if we don't use wood, how do we cook our food then?

Fortunately, we are discovering new uses of old materials. We now know that cow dung can be used to produce a gas which we can burn and use for cooking. What is left behind is an excellent manure. If we use the cow dung in the above ways, we can help satisfy our needs of both fuel and manure, and save the wood for other important needs. If we **have** to use

wood as a fuel in a village, we must set aside a part of the land in the village for planting trees which will grow rapidly.

Sometimes, a material needed by everyone, such as food, sugar or kerosene is in short supply. When this happens, the Government **rations** the material. When a material is rationed, it is shared equally by every person.

(e) There is one specially important point that we should consider while choosing a material for a specific purpose. For example, it will be wise to use cloth woven on handlooms, as a large number of people in villages make a living out of it. If we all were to use mill-made cloth or nylon or terylene our weavers will earn no money. The use of handloom cloth, therefore, helps a large number of people in our country to earn their living.

(f) Very often a material — or an object — has some advantages and some disadvantages. We should carefully ensure that the advantages are more than the disadvantages before deciding to use a material. And when we think of advantages, we should think of advantages not only for us but also to the community in which we live.

(g) We should remember that the most expensive materials or objects are not always the best. For example, the most expensive soap, cycle or radio is not always the best choice.

(h) You will realize that very few of the materials and objects we have are **ideally** suited for the purpose for which they are used. There is, therefore, always a need for producing new materials and objects and finding new and better uses of existing ones. We should, of course, remember that new materials and objects are not **always** better than the existing ones. An old material or object should be replaced by a new one only when the new one has either more advantages or less disadvantages than the older one.

5.4 Waste products

When we use materials and objects, there are often waste products. For example, when we use coal for cooking, the ashes are left behind. Tea leaves are left behind after we have made tea. Old newspapers, used bottles, torn clothes and broken tins are other examples of waste products. What should we do with them?

Some of these wastes can be used again by us for other purposes. This is called **recycling**. Old newspapers and clothes can be made into pulp and used to make new paper. Even the garbage from our homes can be recycled. If garbage is simply thrown out next to

our house, it will soon decay, start smelling and breed bacteria that cause disease. But if we put the garbage in a pit and cover the pit with earth, the garbage will turn into good manure. Manure made in this way is called **compost** and can be used in farms and gardens: we have recycled garbage into a very useful material!

Many factories throw their waste materials into a river. Such waste released into rivers is often poisonous for the fish. Some factories also release their smoke from chimneys into the air. This makes the air unsuitable for breathing. Release of waste into water, air and ground is called **pollution of the environment.** Such pollution is harmful and we must do our best to prevent it. Factories must be asked to recycle their wastes or make them harmless before releasing them into our environment. Fortunately, there are now many methods available to do so; we should insist that they be used.

There are some materials, such as some plastics, which we do not yet know how to recycle. Such materials cannot be simply thrown out anywhere. We should make sure, they are disposed of in a way that causes the least pollution of the environment The best thing, of course, would be to stop using such materials wherever possible. We should remember that the rivers, the seas and the sky are not waste-paper baskets or dustbins!

5.5 Organisation means restriction of freedom

We have learnt that when elements come together to give compounds — that is, get **organised** — the properties of the elements change Some properties are lost, but some are also gained (that is, the compound has some properties which none of the elements had). If we think a little, we will find that the same is also true of our society. We can compare ourselves to elements, and our family, our village or city, and our country to compounds. The family, the village or the city, and the country can do many more things — things which are of benefit to us — than we can do as unorganised individuals. Can we name some of these benefits? For example, could we have had roads, trains and factories if each one of us were to work independently of the others? To obtain these and many more similar benefits, we must be prepared to work as a team and lose a part of our freedom, just as an element loses some of its freedom when it becomes a part of a compound.

CHAPTER 3

SEPARATION OF SUBSTANCES

1. OBSERVATIONS

1.1 We are now familiar with a large number of materials and objects and their uses We can use some objects, like a bucket or hair oil, directly. To many others we have to do something before we can use them. For example, when we eat a banana, we peel off its skin before eating the fruit. Here we **separate** the eatable or the useful part of the object from the part which we do not use.

We can think of a number of similar examples where we separate one material from another. We filter tea to separate the tea leaves before drinking. Mother picks out the stones from rice or wheat grains. You may wish to remove salt dissolved in water, or separate out butter from butter-milk.

1.2 We may wish to separate the components of a mixture for many reasons.

For example, we may wish to find out what elements and compounds the material is made of and in what proportion they are present in the mixture. Or, we may wish to separate useful parts of a mixture from its harmful parts. We, in fact, do this all the time in our daily life — often without knowing it! For example, we breathe in air which is a mixture of several gases. Our body has the ability to separate out and use one of these gases — oxygen — from the air we breathe in; the other gases are breathed out. Plants have the ability to select components of the soil and air that are useful to them.

2. QUESTIONS

2.1 How can we separate the components of a mixture, that is, find out what it is made of ?

2.2 How can we separate the useful part from the useless part in a mixture?

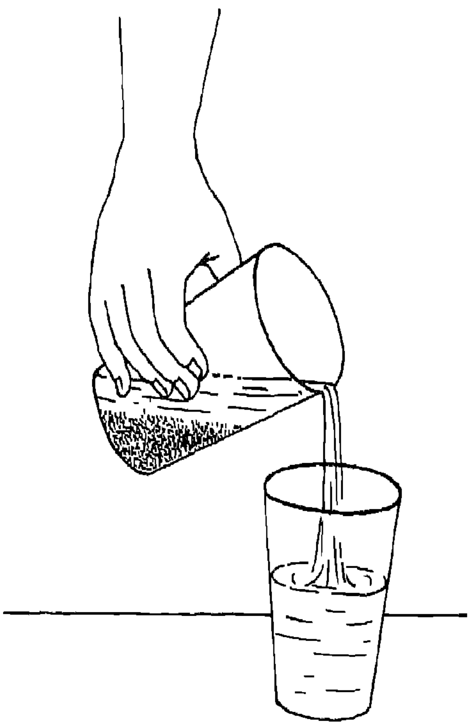
2.3 How can we remove the harmful part of a mixture?

3. LET US FIND OUT

3.1 Decantation

How can we separate a mixture of sand and water?

You will find that if you allow the mixture to stand, the sand will settle at the bottom of the container. Then, if you are careful, you will be able to pour out the water without disturbing the sand. This process is called **decantation (P1)**.



PICTURE 1

Decantation can also be used for separating two liquids such as water and oil. If, however, the two substances dissolve into one another, this method cannot be used. For example, we cannot separate kerosene from petrol by decantation.

3.2 Loading

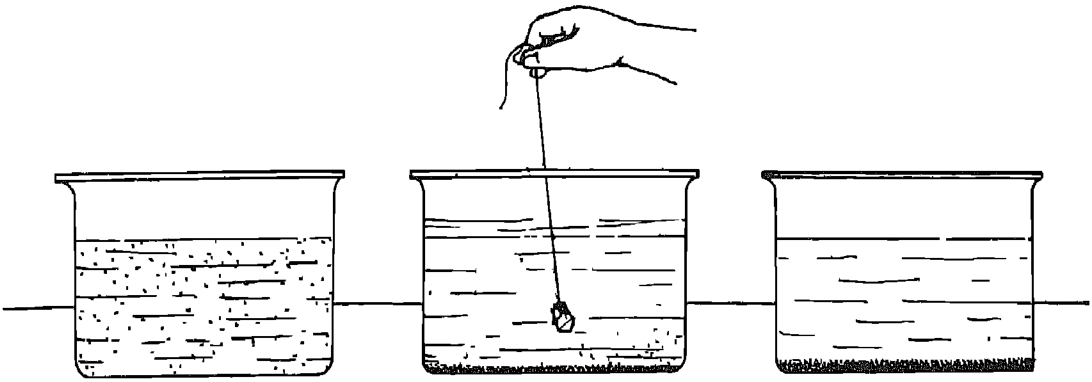
Sometimes very fine dust particles get mixed with the river or pond water, as in the rainy season. It would take a very, very long time for the fine dust particles to settle down if you wish to separate them from water by decantation. You will find that if you take a piece of alum and move it around slowly in the muddy water, the dust particles settle down rapidly. Alum dissolves very easily in water. The dissolving particles of alum **load** the fine dust particles. The dust particles made heavy in this way settle easily to the bottom (**P**2).

We find this happening in nature too. After a shower, the objects at a distance are seen more clearly (**P3**). This is because the dust particles that are present in the air and obstruct our view are swept down by rain.

We often sprinkle water before sweeping a dusty room, so that the dust on the floor may not rise. Here also we are using water to load the dust particles

3.3 Filtration

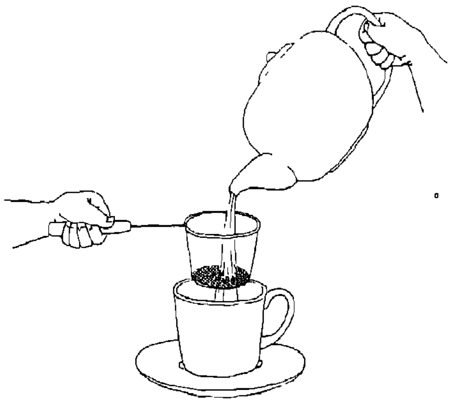
We can separate a mixture of solid



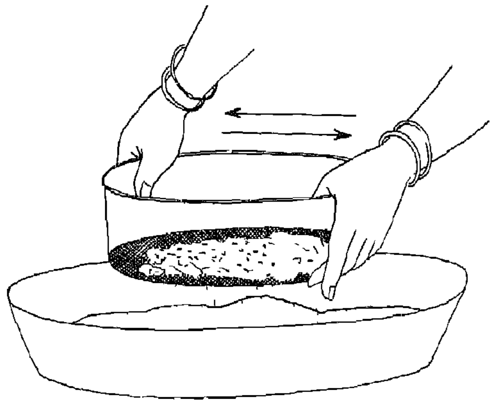
PICTURE 2

PICTURE 3

particles and a liquid in many other ways. When we make tea, we separate the tea leaves from the liquid by using a **filter** such as a wire mesh or a piece of cloth. A filter is an obstacle consisting of holes. Objects bigger than the holes in the filter cannot pass through it and are separated (**P**4). Many substances, such as cotton, glass wool or sand, can be used as filters. The choice of the filter depends upon the size of the particles to be removed. To remove small particles, we would need a filter with **smaller** holes. You



PICTURE 4



PICTURE 5

cannot use a tea strainer to filter turbid water in the rainy season!

A mosquito net is really a filter; it separates mosquitoes from you!

Remember that filters will get choked or dirty after use, and will then need cleaning. Sometimes, the person who runs the tea shop continues to use the **same** piece of cloth to filter tea time after time, and it gets very dirty. Anything dirty is bad for health. If you see anything like this happening, you should bring it to the notice of the persons responsible for it.

Filters that cannot be cleaned must be changed.

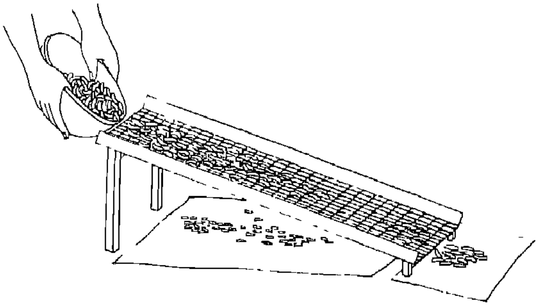
3.4 Sieving

You will find that you can use the principle of filtration also to separate solids of different sizes. For example, you may have seen your mother pass whole wheat flour (*atta*) through a **sieve** (**P**5). The finely ground particles of flour pass through the sieve, while the bigger particles remain on the sieve. You would have noticed that the sieve has holes, all of the same size. The larger the size of the hole, the larger will be the size of the particles it will allow to go through. We use sieves of different hole-size (or mesh), depending upon the size of the particles we wish to separate.

The above method of separation is called **sieving**; it can be used for rather big objects as well. For example, eggs in a poultry are made to roll gently on a wire net: the smaller eggs drop down (on soft grass so that they do not break) while larger eggs are held back Cashewnuts of different **sizes** are separated in cashewnut factories in Kerala in a similar way (**P**6).

3.5 Separation by a magnet

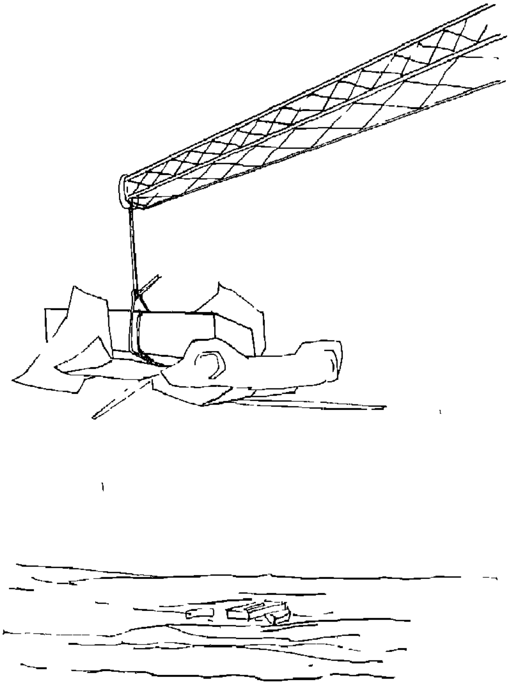
Sometimes the solids that we wish to separate out from a mixture have



PICTURE 6

special properties which we can use for the separation For example, if iron particles are mixed with sand, we can use a magnet to pick out the iron particles.

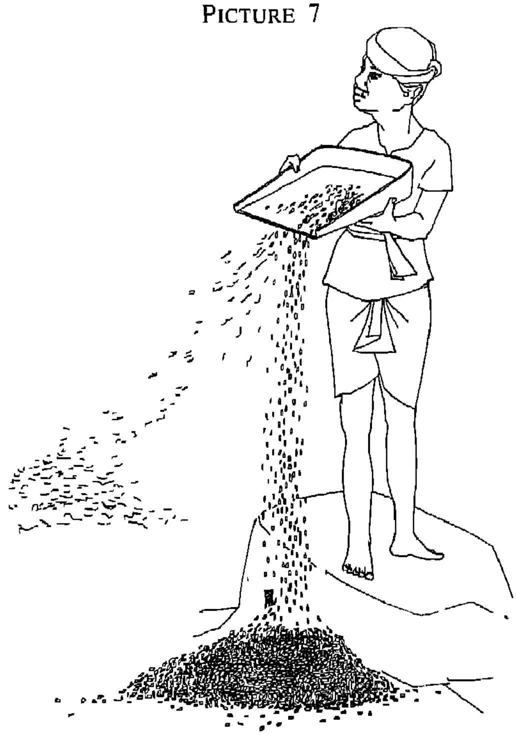
The waste material of many factories often contains 'scrap' (that is, waste) iron; this is generally dumped in a heap along with other wastes. One would like to pick out the scrap iron from this heap because the iron can be used again (**recycled**) A crane carrying a huge electrical magnet is often used to do the picking (**P**7).



PICTURE 7

3.6 Winnowing

Have you seen a farmer separating wheat grains from the husk? A farmer, standing on a high platform, simply **releases** the wheat from a winnow. The wind has very little effect on the wheat grains because they are heavy. The husk, being light, is blown away from the wheat by the wind (**P**8).



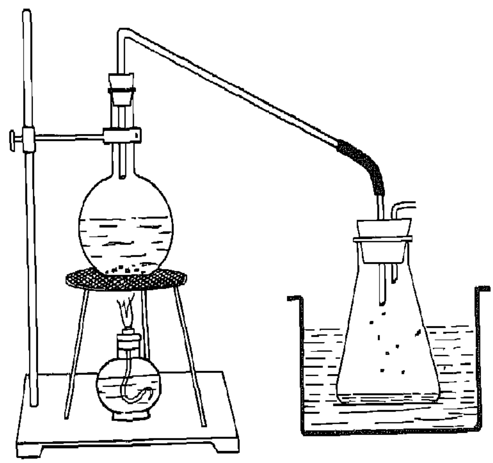
PICTURE 8

You will notice that all methods of separation are based on one basic principle. This principle is that

different materials have different properties and that one can use this difference to separate them We have studied several methods of separation depending upon differences in the size or the weight of objects. To separate iron from a mixture, we made use of the fact that iron is magnetic while most other metals are not magnetic. Therefore, when you wish to separate the components of a mixture, first try to find out some property which would be different for the different components.

3:7 Distillation

How can we separate two liquids that dissolve into each other? We have seen that we cannot separate them by decantation. Let us think of some property that may be different for different liquids. We know that some liquids boil at low temperatures, whereas some others boil at high temperatures. We can use this difference to separate a mixture of such liquids. As an example, let us take a mixture of water and alcohol (spirit). Water boils at 100°C, but alcohol boils at 80°C. Therefore, if we heat the mixture, alcohol will begin to boil earlier than water. On boiling, it will be converted into gas. This gas will spread everywhere in the apparatus shown above (**P9**). When it comes to the cooler parts of the apparatus, it would condense to give liquid alcohol. Water would have been left behind. This process of separating liquids from a mixture is known as **distillation.** Distillation can also be made to separate a liquid from a solid (for example, water from salt).



PICTURE 9

3.8 Evaporation and crystallisation

If we have a solid dissolved in a liquid, like common salt dissolved in water, how can we separate the two? One way would be to distil the water off. But there is another, simpler method, as the following experiment will show.

Take a few drops of salty water in a dish and leave the dish in the sun. You will soon find that the water has gone away (**evaporated**), leaving behind some solid (small **crystals**) on the dish. If you taste it, you will find it

salty. This is the common salt we wanted to separate.

The above process is in fact used on a large scale to obtain common salt from sea water (P10). Sea water is collected in open, shallow beds at high tide. In the hot sun the water evaporates and the salt crystallises out. The salt is then collected in heaps.

We can easily obtain large crystals from some solutions. Dissolve as much alum as you can in a cup of water. If you heat the water a little, you will find that you can dissolve more alum in it. When no more alum dissolves in it, filter the solution while it is hot. Take the clean solution in another cup. Suspend a thread in the cup and leave the solution uncovered and undisturbed. In a day or two, you will find a crystal growing at the tip of the string. The crystal will become bigger everyday. If you are patient you will be rewarded with a beautiful big crystal. Different substances give crystals of different shapes and colour. Crystal growing is, therefore, lots of fun.

3.9 Sublimation

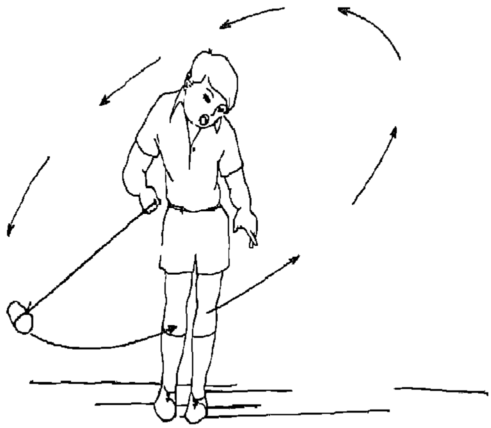
Most solids, upon heating, become liquids. Upon further heating, the liquid becomes a gas. But there are some solids that change directly to gas upon heating, without becoming

PICTURE 10

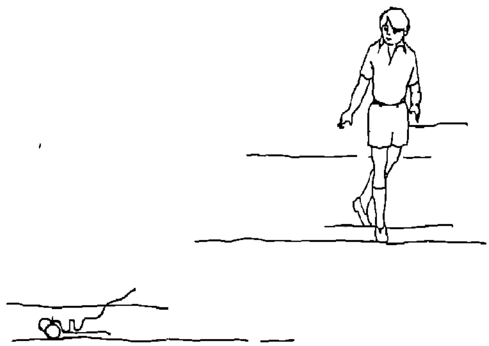
liquid. Camphor and naphthalene are two examples of such special solids. This process of taking a short cut from solid directly to gas is called **sublimation**.

Suppose you want to separate a mixture of salt and camphor. You can use the fact that camphor sublimes while salt does not. Take the mixture in a clean tall glass bottle and close the top. Now warm the bottom of the bottle with some hot water. Camphor in the mixture will sublime and you would see white fumes of camphor. The upper portion of the bottle would be cooler than the bottom; the fumes of camphor will, therefore, condense at the tip to give back solid camphor. The salt will be left behind at the bottom of the bottle.

Camphor is usually stored in small closed vessels. Can you now say why?



PICTURE 11a



PICTURE 11b

3.10 Centrifugation

If you tie a stone to the end of a string and hurl it around, you will find that the string becomes tight (**P**11a). The stone seems to pull the string If you let go the string, the stone will fly away (**P**11b). An object moving in a circle always has the tendency to fly off.

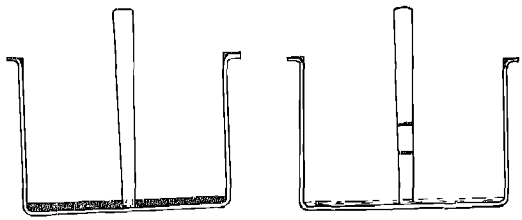
We can make use of the above tendency to separate heavy and light materials mixed together. If a mixture of two such materials insoluble in water is suspended in water in a closed bottle, and the bottle hurled around, the heavy material will be the first to move towards the bottom; the lighter material will remain behind. The separation would be better if the bottle is hurled faster, or if one material is very much heavier than the other. What do you think would happen if the two materials are equally heavy or equally light? Obviously, we would not be able to separate them by this method.

This process of separation is called **centrifugation.** It is used widely in dairies to separate cream from milk. You will enjoy seeing this separation if you visit a dairy.

You might have seen curd being churned. During churning, butter separates from the curd. The butter floats and is easily removed; what is left behind is buttermilk. Do you notice any similarities between churning and centrifugation? Do you also see any **difference**?

3.11 Chromatography

Take a drop of red ink and mix it in a container with a drop of blue ink. Add 20 drops of water. Then let a thin strip of filter or blotting paper, or a white chalk piece, stand in the mixture so that at least 5 cm of the paper or the chalk is above the surface of the mixture. Wait for 30 minutes. You will find that the red and the blue inks have separated out (**P**12)! How did this happen? It happened because the chalk (or the paper) has a different



PICTURE 12

amount of liking, or **affinity**, as it is called, for the red and the blue inks. The chalk or the paper holds the colour it likes more strongly. This colour, therefore, moves through more slowly than the other. Separation of substances on this principle is called **chromatography**. In place of chalk or filter papers, one can use a large number of other materials which have a different degree of 'liking' for different substances. Chromatography is very widely used to separate substances which are available only in very small quantities.

4. ACTIVITIES

4.1 Suppose the wheat you buy from the market contains a lot of moth-eaten grains, husk and dust. How will you remove these undesirable impurities? Check your answer using a small sample of the wheat containing such impurities.

4.2 Prepare a mixture of sand, common salt and sawdust. Try to separate the three components of this mixture.

4.3 Try to separate salt from sea water or from a solution of common salt in water.

4.4 Take a glass of drinking water. How will you know whether this water is pure? If it is not, purify the water.

4.5 If, by chance, a packet of rice and a packet of salt fall on a dirty floor, and the salt and the rice get mixed with the dust on the floor, how will you get back your rice and your salt, both free of dust?

4.6 Suggest four methods of separating small iron nails from sand.

4.7 Suppose, while carrying a packet of common pins, you fall down, and the pins scatter over a large area and get mixed with dust. How will you collect all the pins free of dust in the shortest possible time?

4.8 You have learnt to prepare alum crystals. Try to prepare crystals of common salt, sugar and copper sulphate (blue vitriol) In each case, when you prepare the solution, make sure that you add the material to hot water until it no more dissolves. Filter the solution while it is hot and then suspend a thread in each solution Write down all the observations you make and describe the crystals you obtain in as much detail as you can. Did you obtain crystals from all solutions equally easily?

Warning: Copper sulphate is poisonous.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Purification

We have learnt that many materials we use are mixtures of various substances. In order to separate the components of a mixture, we can use a variety of methods. The process of obtaining **one and only one** substance from a mixture is called **purification**. A substance is called pure when it is **one and only one**, and nothing else is present in it. If anything else is present in it, the substance becomes impure. In practice, we find that to obtain one and only one substance from a mixture, that is, to purify the substance—we often have to use a number of methods, one after the other. At each step, the substance becomes less and less impure, till finally we have the pure substance.

5.2 Impurities

Some impurities are bad, harmful or undesirable. Examples are: stone pieces in grain, banana in butter, bacteria (a kind of germs about which you will learn later) in water, fungus (another kind of germ) in bread, *kesari dal* (which causes a terrible disease) in *besan* or in *arhar (tur) dal*, argemone

oil in mustard oil, papaya seeds in black pepper and lead chromate in turmeric. Some impurities are harmless, like a small number of dead bacteria in boiled water. Some impurities are even useful. A common example is naturally-occurring water which contains various useful salts dissolved in it. These salts make the water impure but many of them are essential in our diet, and water provides them to us in a convenient form. The beautiful red precious stone we call ruby is beautiful and precious because of an impurity; the same is the case with pearls. Sometimes, we even purposely add impurities to pure substances to make them more useful. For example, pure germanium is a metal of little use, but when a small amount of impurity is added to it, we get a **transistor**. Transistors are widely used, for example, in radios. Ornaments are not made out of pure gold because it is too soft; a small amount of copper is always added to gold before the ornaments are made.

You should learn to identify carefully harmful and undesirable impurities. You have learnt some of the methods by which you can remove such impurities.

5.3 Cleaning is a kind of separation

One of the common, undesirable impurities we come across in our everyday life is dust. We use many methods to remove dust. For example, we sweep the floor and we wash our clothes to remove dust from them We wash vegetables to remove dust as well as other impurities. Cleaning, therefore, is a kind of separation. If you watch carefully, you will see that many of the methods of separation that you have studied are often used in our daily life.

5.4 The principle

All methods of separation, whether used in our homes, farms or factories, are based on just one principle: different materials have different properties and we can use this difference in properties to separate materials. You will also find that the use of machines for separating materials is increasing everyday in our farms and factories. Machines often do the job faster, cheaper and much better. If a useful and desirable machine is costly, several users can come together to share its cost and its use.

CHAPTER 4

CHANGES AROUND US

1. OBSERVATIONS

We find changes taking place all around us. We give below some examples.

(**a**) Many changes take place when the day ends and the night sets in (**P** 1).

(**b**) **During** the day, the length of the shadow changes. The shadows are long in the morning and in the evening. They are small at noon (**P** 2).

(**c**) Ice, upon heating, changes to water Water, upon heating, boils and changes into steam (**P** 2) Steam, upon cooling, can again be changed into water.

(**d**) The taste of water changes when some salt is dissolved in it. Can you now guess why water from different sources tastes different?

(**e**) When coal burns, it changes into ash and smoke.

(**f**) When wood burns, it changes into charcoal, ash and smoke.

(**g**) Shoes, clothes, pencils, torch-light batteries, ploughs, bicycle

The day	*The night*
There is lot of light	There is very little light.
It is usually warm	It is usually cool.
Stars are not visible	Stars are visible.
Animals like houseflies, crows, sparrows and butterflies are active	These animals are not active
Animals like bats, owls, tigers, foxes and cockroaches are not active	These animals are active
Flowers like sunflower and *Portulaca* bloom.	These flowers do not bloom.
Flowers like *Rat-ki-Rani* and flowers of certain cacti do not bloom	These flowers bloom.

PICTURE 1

tyres and horse-shoes change when they wear out. For example, a pencil becomes smaller when it wears out. Can you list the changes that happen when the other objects we have named above wear out?

(**h**) When objects break, they change. When a glass tumbler breaks, it changes from a glass tumbler to broken glass pieces. A glass tumbler can be used for drinking water, the broken pieces cannot be so used!

(**i**) Wheat grains change when they are ground into flour. We can make *chapatis* out of wheat **flour**, but not from wheat **grains**.

(**j**) Dough changes when you roll it for making a *chapati*.

(**k**) Leaves change colour. Give examples from your experience.

(**l**) Iron objects, like nails or pins, change when they rust. Try pushing a good common pin and a rusted one through a bunch of papers. Do you notice any difference?

(**m**) Rubber changes when it is stretched. Spring, too, changes when it is stretched.

(**n**) Milk changes when it is turned into curd.

(**o**) All items of food change when they go bad. The smell of food changes when it goes bad. List other changes that happen when food goes bad.

(**p**) We all change when we grow. List changes that occur when a child grows into an adult, a calf grows into a cow, or a sapling grows into a tree.

(**q**) A solution changes when a crystal grows in it List the changes that occur during crystallization.

(**r**) Dead plants change when they become manure in a dumping pit (called a **compost** pit).

(**s**) When a photographer takes your photograph, the photographic film he uses changes.

(**t**) A moist mixture of the gases, hydrogen and oxygen, changes into water when an electric spark is passed through the mixture.

(**u**) The weather changes during the year.

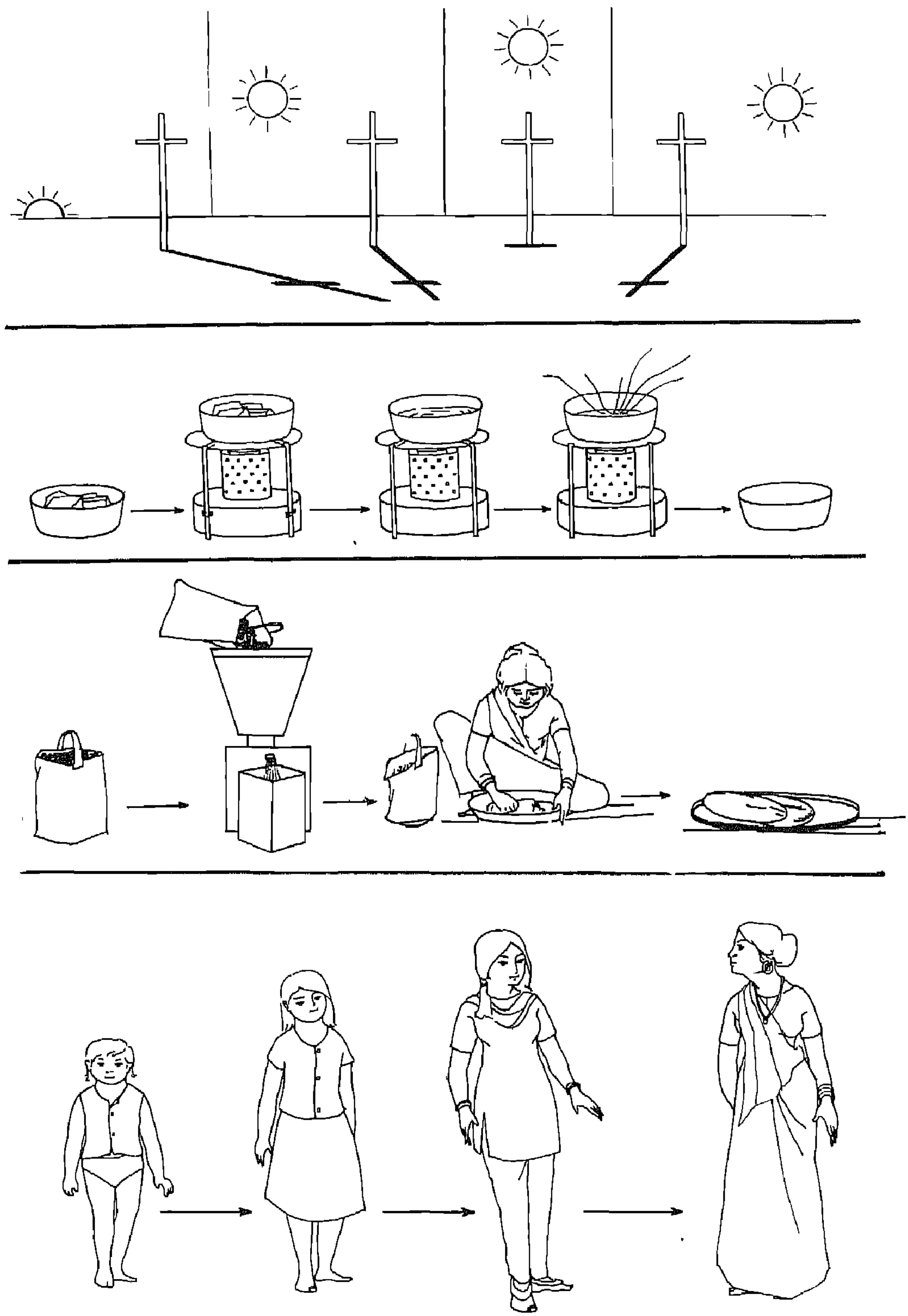
(**v**) The appearance of moon changes from night to night.

(**w**) Glycerine and potassium permanganate change when they are brought together.

(**x**) Turmeric powder changes when you squeeze lemon on it.

(**y**) Write your name on a piece of paper with lemon juice instead of ink. You will see your handwriting changing colour (from colourless to brown), if you warm the paper over a flame.

(**z**) An iron pin changes when it is brought in contact with a magnet.



PICTURE 2

2. QUESTIONS

2.1 Can we classify changes?

2.2 What causes these changes?

2.3 What happens when things change?

2.4 Can we prevent, speed up or reverse changes, that is to say, can we control changes?

3. LET US FIND OUT

3.1 Slow and fast changes

We can classify changes in a variety of ways. For example, some changes are **fast**, like the burning of a match stick, the change that occurs in a photographic plate when a photograph is taken, or the breaking of a glass tumbler. These changes occur in less than a second. Some other changes are **slow**, like the rusting of an iron nail, the change of seasons, or the growth of a plant. These changes take place over hours, days or months.

3.2 Desirable and undesirable changes

Some changes are **desirable**, like the changes that occur when milk becomes curd or when dead plants turn into manure. Some other changes are **undesirable**, like the breaking of a glass tumbler or the changes that occur when food goes bad You will realise that the same change can be desirable at one time but undesirable at some other time. For example, the changes that occur when fuels (coal, wood, or oil) are burnt are desirable when put to use for cooking, moving a train or running a factory The same changes also occur when a house catches fire, but then they are undesirable. Sometimes, we deliberately set fire to grass to prepare the land for the next crop. We would not, however, like the grass in our haystack to catch fire. For some changes it is difficult to say whether they are desirable or undesirable. For example, would you consider the changes that occur daily in the appearance of the moon as desirable or undesirable?

3.3 Periodic and non-periodic changes

Some changes are **periodic**, that is, they occur again and again after a fixed interval of time. The phases of moon, the high and low tides of the sea, the seasons, our heartbeat and the arrival and departure of trains at a railway station, are some examples of periodic changes. If the change is

periodic, you can **predict** when it will occur again.

Some other changes are **not periodic**. The rusting of an iron nail, the melting of ice into water, the appearance of some comets or of a shooting star in the sky, and the growth of a plant are examples of **non-periodic** changes. It cannot be predicted, when any one of these changes will occur the next time. Are any of these changes such that they occur again and again but not at fixed intervals of time?

3.4 Reversible and irreversible changes

Some changes are **reversible**. For example, ice, upon heating, changes into water. It is also possible to bring about the opposite change: water, when cooled, changes into ice. The leaves of the plant, **touch-me-not**, fold when you touch them. After a while the leaves open out again. The leaves of the **rain tree** fold after sunset and open out again after sunrise. The pupils of our eyes become big in poor light but become small again when we go back to bright light. You can produce water from hydrogen and oxygen, you can also break water down to produce hydrogen and oxygen. These are some examples of reversible changes.

Other changes are **irreversible** For example, when a piece of coal burns, it changes into ash and smoke. You cannot get back a piece of coal from the ash and the smoke. Aging is another irreversible change. You cannot convert an old animal into a young animal! Wearing out of materials is also irreversible.

Can you think of more examples of reversible and irreversible changes?

3.5 A change may affect a few or many properties

In the case of some changes, only a small number of properties of the material change. For example, when you break a piece of chalk, only its size changes But it still remains a chalk. When a glass tumbler breaks, its size and shape change, and its ability to hold water may be lost. But the material of which the tumbler is made does not change. All the broken fragments are still made of glass.

On the other hand, there are changes in which a large number of properties change. When food is cooked, many properties change. Some of these are: colour, taste, smell, hardness, consistency, ease with which the food can be digested, and the ease with which it can be spoiled! Similarly, when hydrogen and oxygen combine to give water, a large number of

properties change. Can you list some of these properties?

3.6 Physical and chemical changes

You have learnt that all objects and materials are made of elements and compounds. In some of the changes listed above, the nature of the elements and compounds of which the material or the object is made does not change. Such changes are called **physical changes**. For example, when a glass tumbler breaks, its size, shape and some other properties change but the material of which the tumbler is made does not change. Glass is mainly made of a compound of the two elements, silicon and oxygen. The broken pieces continue to be made of the same compound of silicon and oxygen. The glass tumbler, therefore, undergoes a physical change when it breaks. In fact, only a physical change occurs when any object breaks.

On the other hand, when hydrogen and oxygen combine to give water, the nature of the materials changes. Hydrogen and oxygen are both elements while water is a compound with properties different from those of hydrogen and oxygen. Similarly when coal burns, carbon in the coal combines with oxygen of the air to produce carbon dioxide. The properties of coal and oxygen are different from the properties of carbon dioxide and ash. Such changes are called **chemical changes**. In a chemical change, therefore, the nature of the material changes.

You will find that the classification of changes into physical changes and chemical changes is often useful.

3.7 Where to look for an interaction?

You will find that in all changes two or more materials come together, **interact** (that is act on each other) and change some properties of each other. The evidence for the interaction can be found in any of the interacting materials. When we sharpen the pencil with a blade, the pencil and the blade come together and interact. In this process, the pencil changes: it becomes lighter and its point becomes sharper. The blade also changes its properties (it becomes blunt with use), but this change is too small to be noticed if the blade has been used only once. Therefore, if we want to know whether or not a particular pencil has interacted with a blade, we should look for a change in the **pencil**. If we are looking for evidence of interaction, we should look for a change in those materials that undergo the **larger** change

Let us take another example. When a candle burns, it interacts with

the oxygen of the air and undergoes a chemical change. During this change two things happen: carbon dioxide is formed, and light and heat are given off. Would it not be easier to detect the interaction by looking at the candle rather than by looking at the air ?

When we strike a match, the evidence of interaction is more easily seen in the match stick than in the match box.

3.8 Can we control changes?

We can control (that is, speed up, slow down or prevent) **some** changes. For example, we can prevent, or slow down the spoilage of food or the rusting of iron objects. Can you say how? Can you also give other examples of changes we can control?

There are, of course, many changes over which we have no control. For example, we cannot control the phases of the moon, the change from day to night and then from night to day, or the seasons. Can you give more examples of changes that we cannot control?

We try to slow down or prevent undesirable changes and try to speed up desirable changes, if we can.

4. ACTIVITIES

4.1 Soak a few seeds of gram in a cup of water. Observe and record the changes occurring in the seeds every day, for three or four days. Classify the changes you observe in the various groups we have discussed.

4.2 If you dissolve sugar in water, it changes. Can you think of other ways of changing sugar? Bring about these changes if possible and record in every case the properties of sugar that change. Classify these changes in the various groups we have discussed.

4.3 Prepare a mixture of sulphur and iron filings. Record how the mixture reacts to a magnet. Heat the mixture and record how it reacts to a magnet now. Record all other changes that are seen when you heat the mixture. Did heating the mixture result in a physical or a chemical change?

4.4 Heat a piece of wax for about five minutes and allow it to cool slowly. Record your observations every minute during the process of heating and cooling. What are the changes you observed? Would you call these changes physical or chemical?

4.5 Record all the changes that take place at or near the site at which a new building is being constructed in your locality. Classify these changes in as many ways as you can.

4.6 Make a list of all the changes you

observed during a particular day. Compare your observations with those of your classmates.

4.7 How many changes occur when your teacher writes on the blackboard? How many of these changes are reversible?

4.8 You would have noticed that mangoes and bananas are often ripened inside the house after they have been taken off the tree. Record all the visible changes that occur when a raw banana or a raw mango ripens.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Changes are of many types

We have seen that everything around us changes. Changes may be of different types. They may be physical or chemical, reversible or irreversible; they may occur very fast or very slow. Can you think of anything that does not change?

In a physical change, the nature of the material is not altered: it continues to be made of the same elements and compounds. Rain is a common example of physical change. In a chemical change, a material changes into some other material. The new material is made up of different compounds and elements than the starting material.

5.2 Controlling changes

We take certain steps in our everyday life to prevent undesirable changes. For example, we smear grease (or oil) on iron tools, such as scissors or ploughs, to prevent rusting. We paint or polish furniture to protect it from wearing off too quickly. On the other hand, we try to speed up desirable changes like ripening of fruits. As our knowledge progresses, we acquire the means to control more and more changes.

We often have to decide which of the changes we should encourage and which we should not. There are some changes which benefit only a few persons at the cost of many others. We should try to prevent such changes. There are other changes which benefit a large number of people; we should try to bring about these changes. Let us take an interesting example.

At home your father **changes** his income (money) into material and services you need.	The goods produced in the country (such as grains, metals and electricity) are the income of the country.
He can do so in many ways.	The income of the country can be **changed** into many different services for the people.
He can, for example, **change** his money into expensive clothes for himself and into drink, leaving very little for the family.	The income, for example, can be used to build palaces and excellent schools for a few, and to produce steel for making cars etc. This leaves very little money for building houses, bridges, hospitals or buses for the majority.
Or, he can **change** his money into durable clothes, food and education for everyone in the family. Which decision of your father would you agree with?	Or the income can be used for building dams, many simple houses, schools in every village, and bridges and buses. Which decision of the Government would you agree with?
In the house, the father and the mother decide what should be bought with the money. From time to time they change these decisions. We all should do our best to see that every such change is better for the family taken as a whole and not just for one member of the family.	In the country, the Government decides what services should it provide to the people with its income. From time to time the Government changes its decisions. We should do our best to ensure that every such change is better for the country as a whole, and not just for a few individuals in the country.

To take some more examples: milk can be used for making sweets for a few people or given to many children; and alcohol can be used for drinking or as a fuel for producing power. What will be your choices?

5.3 Think before you change something

We should first find out if the change is reversible or not. We should think carefully before we bring about irreversible changes. For example, we are at present short of food. Should we, therefore, convert all our forests into wheat fields?

Some changes may seem to be of immediate use but turn out to be harmful later. For example, we often cut down trees in the forests for timber or firewood, to make room for agricultural land or to build houses. As a result of this action the landscape changes. If too many trees are cut, the rainfall in the area would decrease and the soil would become loose and less fertile. In the long run, the place becomes unfit for agriculture.

5.4 Changes in beliefs

Just as objects around us change, our beliefs also change. For example, until recently, many people believed that smallpox was caused by the anger of a goddess. We know now that smallpox is caused by a germ (**virus**). This knowledge allows us to prevent this disease by vaccination.

As students of science, you will see many such examples of changes in our habits and beliefs. We should resist those changes which will bring harm to us and to others around us. We should readily accept those changes which will bring benefit to a large number of people, and do our best to try to speed up such changes.

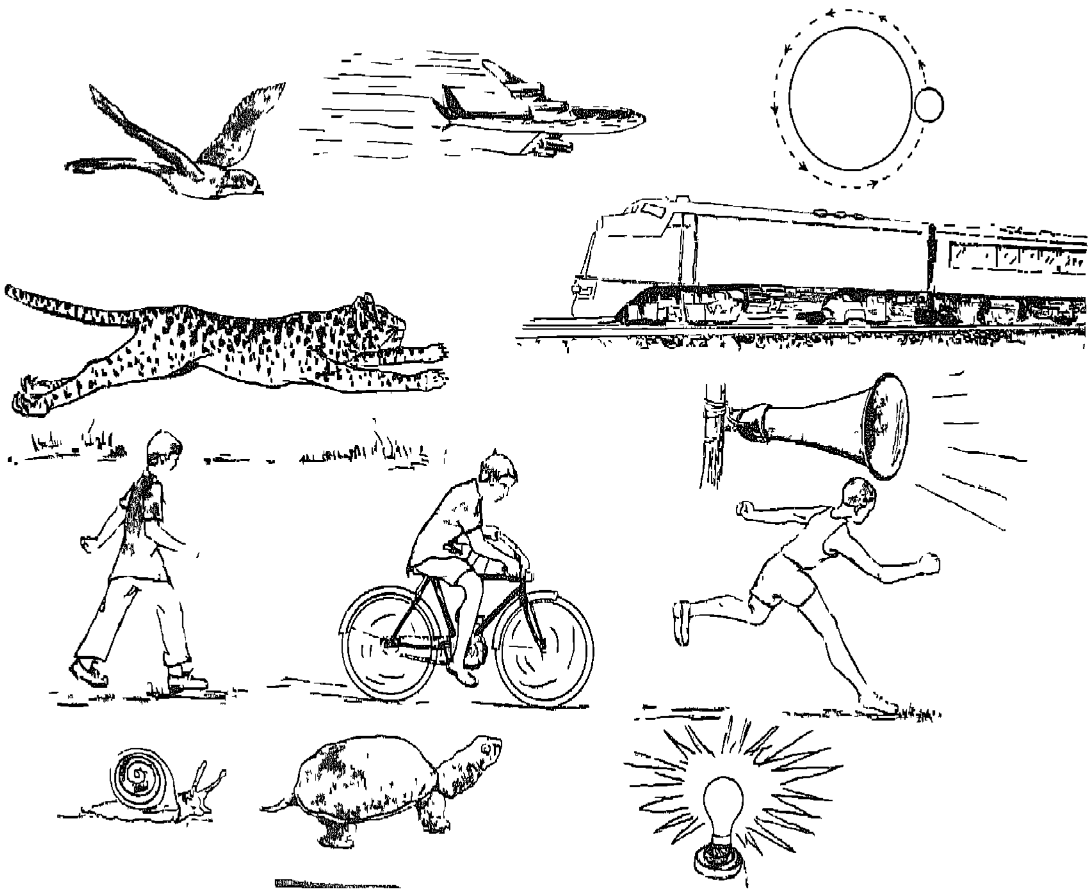
CHAPTER 5

MOTION, FORCE AND PRESSURE

1. OBSERVATIONS

1.1 We see things moving around us (**P** 1) all the time. Some of the movements we see are slow, such as the crawling of a tortoise, a slug or an earthworm, the opening up of a flower, or the curling of leaves during drying. Some other movements are fast, like the movement of a bullet, the galloping of a horse, the flight of a jet plane, and the leaps of tigers and antelopes.

The following table gives the distances covered by a few selected objects in one minute. Which one of



these objects would you consider "slow" and which one "fast"?

Serial number	*Object*	*Distance (in metres) covered in one minute*
1	Slug or snail	0 1
2	Tortoise	6-8
3	Man walking	50-100
4	Man riding a bicycle	150-250
5	Fastest man on earth (1975)	596.42
6	Rajdhani Express (Bombay to Delhi) (1976)	1359
7	Cheetah (the fastest land animal)	1740
8	Swift (the fastest bird)	6000
9	Jumbo Jet	16000
10	Sound in air	19,800
11	*Aryabhata*	460,000
12	Earth moving round the sun	1,794,000
13	Light	18,000,000,000

1.2 Look at the pictures in the set **P2.**

Some objects move **in a line**, such as a ball rolled on a plane ground, a wild buffalo charging, a carrom-board coin, and light.

Some objects move **in a circle**; examples are a merry-go-round, a potter's wheel, and the wheel of a *charkha* or of a sewing machine.

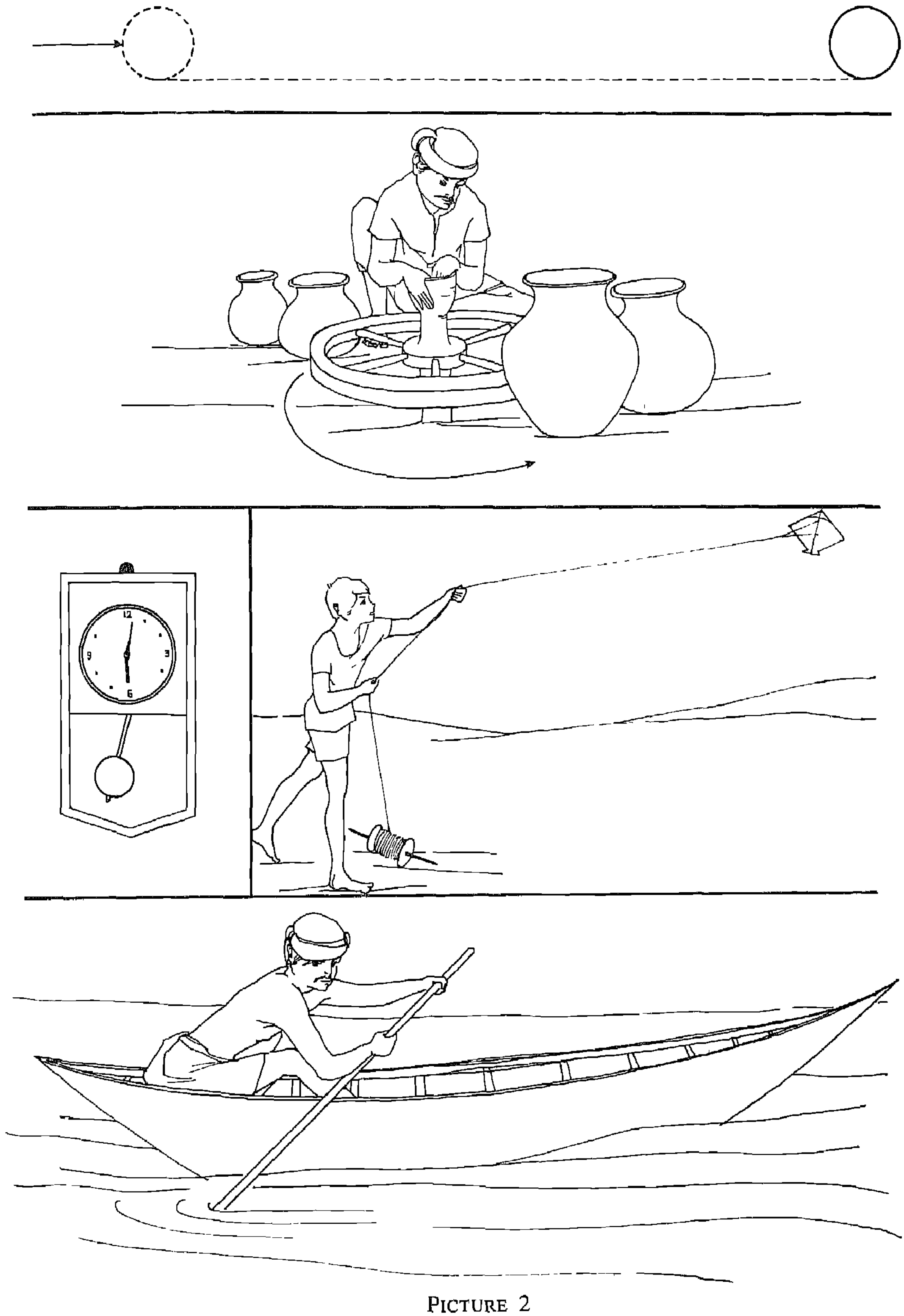
Some objects move **to and fro**, such as the swing, the pendulum, the branches of a tree in the wind and the needle of a sewing machine.

Some objects move **repetitively**, such as the fingers of a *tabla* or a *sitar* player, and the hands of a man rowing a boat. The movements of a brick-layer or of a farmer sowing seeds are also repetitive. Your hands and feet undergo repetitive motion when you walk.

Some movements are haphazard, that is, irregular or **random**. The movements of a house fly or a mosquito, and your own movements in the house during a day, are random.

Some movements are **periodic**, that is, they are repetitive and **take place at regular intervals of time**. The motion of the earth around the sun, the to-and-fro motion of the pendulum of a clock, and the beating of the heart are all examples of periodic motion. **All periodic motions are repetitive but all repetitive motions are not periodic.** Periodic motions can be used to mark intervals of time, that is, they can be used as clocks.

Some objects change their position when they move. Examples are a railway train moving from one station to the next, and a flying kite. When an object changes its position, we call its motion **translational** motion. Can you think of more examples of translational motion?



PICTURE 2

Some objects can move without necessarily changing their position. For example, a top or a fan can rotate quite fast without moving from one place to another. Such a motion is called **spinning** or rotational motion. The earth spins around its axis once every twenty-four hours.

There is yet another kind of motion in which the entire object does not move. What happens when you pluck the strings of a *sitar*? Only the string moves — not the whole *sitar* — and this motion is neither translational nor rotational. We call the motion of the string **vibrational** motion. Here, the object that moves changes its shape or its size during the movement. Another example of vibrational motion is the expansion and contraction of your chest when you breathe.

An object can have different kinds of motion at different times. For example, you can walk, jump, run and spin An object can also have more than one kind of motion at the same time, that is, **simultaneously**. When a spin bowler bowls a cricket ball, the ball shows translational as well as spinning motion at the same time. The top spins around itself and can also move from place to place. You ombine several motions when you do crobatics. And while you are doing **acrobatics** your chest is performing vibrational motion as well!

1.3 You can make things move in a variety of ways. For example, you can push an object or pull it. You may push an object with your hands or you may use a bow or a rubber catapult to do so. Sometimes we use animals to move other objects. For example, we use bullocks to move a plough or a cart, a horse to move us, an elephant to move logs in a forest, camels to pull carts in a desert, and donkeys to carry loads. In cold countries, dogs and reindeer are used to pull carts (called **sledges**) on snow.

We also use non-living agents to move objects. For example, we use air to move a sailboat or a windmill, and water to move a watermill or to move logs down a river. You would have seen a *phirki* turning (rotating) in the wind. It rotates faster if you run with it. On the same principle, water falling from a height is used to turn a generator which produces electricity.

We have seen that objects can be moved by living agents like man or other animals, or by non-living agents like wind or water. Often, we see objects which seem to move all by themselves, without any outside help (**P**3a, b, c, d) For example:

(a) Animals move by themselves. We ourselves walk, run and move our hands, and

nothing — living or non-living — seems to be pushing us to do so (**P**3a).

(**b**) A ball rolls down when put on a slope (**P**3d). River or rain water tends to flow all by itself towards lower parts of the ground

(**c**) We have seen objects moving in the sky, such as the sun, the moon, the planets and the shooting stars.

(**d**) The smoke from a lighted *agarbatti* moves and spreads all over the room (**P**3b)

(**e**) If a pinch of potassium permanganate is put in a glass of water, the colour moves and spreads everywhere in the water until the entire glass of water is pink.

(**f**) If a drop of red ink is put on a blotting paper, the colour moves on the filter paper.

(**g**) When you light a bulb, a candle or a lantern, the light spreads everywhere.

(**h**) When you speak or sing, the sound spreads. You can hear the train or the bus from a distance because their sound moves towards you.

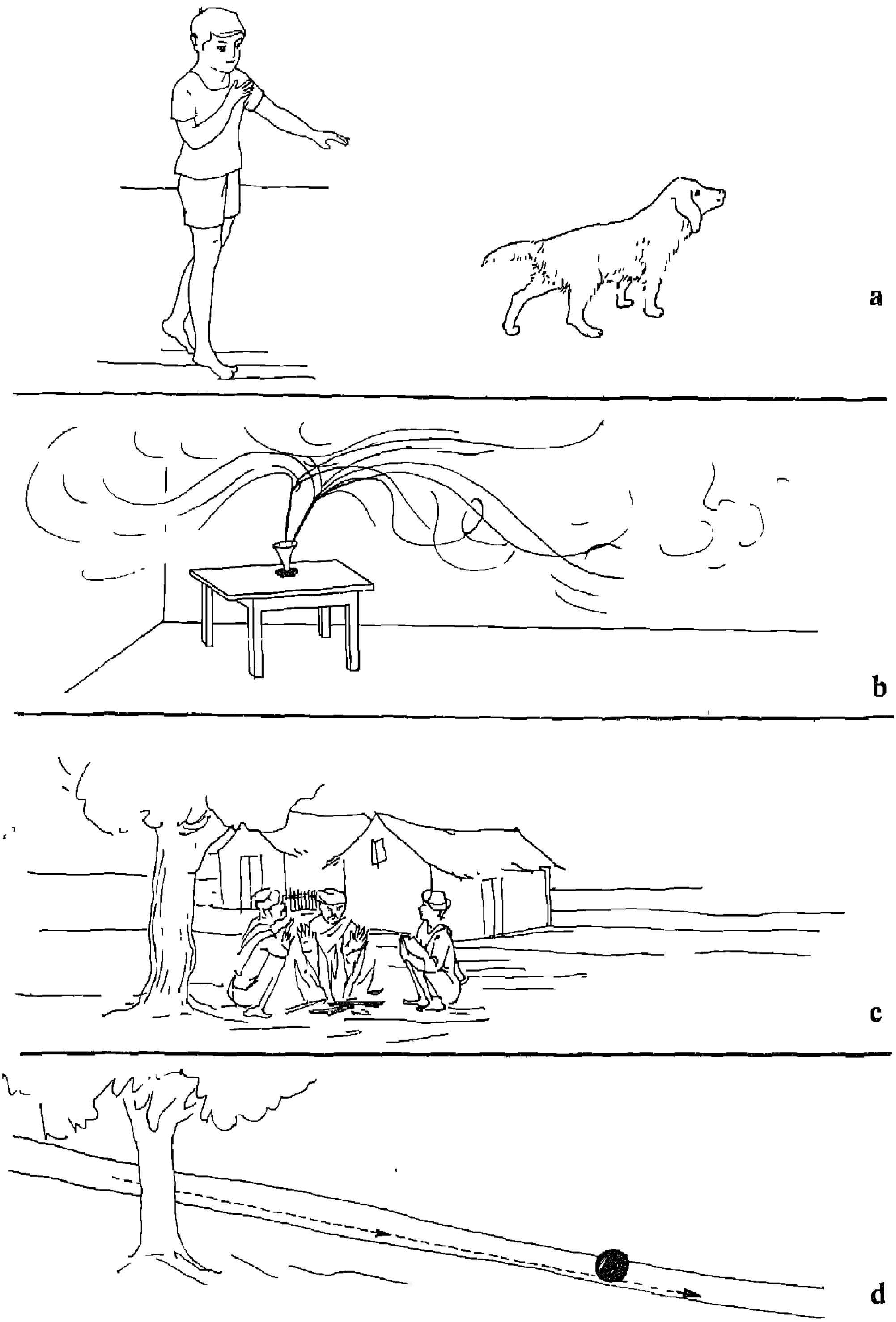
(**i**) If you sit near a fire, you feel warm (**P**3c) Heat also moves and spreads, just as light and sound do

(**j**) Electricity can move through a wire. That is why wires are used for flow of electricity from the power station to our house or farm

1.4 We can also make some moving objects stop. For example, we can make ourselves stop while walking or running. We stop a moving bicycle, a car, a bus or a train by applying brakes. A fielder in a cricket field stops a moving ball with his hands. You would notice that you need to put in more and more effort to stop an object as its speed increases. For example, you have to apply the brakes harder to stop, if you are going faster on a bicycle.

Some moving objects appear to stop by themselves. For example, a ball rolling on flat ground stops after a time. An object thrown up in the air stops at a point before it starts coming down. If you stop pedalling a bicycle, it will lose speed and finally stop without your applying brakes. A moving swing will soon come to a stop if you do not push it again.

1.5 Objects always take **time** to cover a distance.



PICTURE 3

2. QUESTIONS

2.1 What makes things, that are stationary, move — or things that are moving, stop?

2.2 How are different kinds of motion caused?

2.3 Can we control motion? If so, how?

3. LET US FIND OUT

3.1 Force changes motion

You would have noticed that whenever you wish to change the motion of an object, that is to say, you wish to

(i) make it move slower or faster,
(ii) stop it if it is moving,
(iii) move it, if it is at rest (that is, not moving), or
(iv) change the direction in which it is moving,

you have to do something to the object. In every case, you have to exert a **force** on the object to change its motion.

3.2 Types of forces

There are many ways of applying a force:

(a) We may push, pull or lift an object ourselves.
(b) We may use an animal to do so.
(c) We may use a device like a bow or a catapult.
(d) Some materials are capable of exerting a special kind of force. For example, a magnet is capable of attracting (that is, pulling) objects made of iron, cobalt or nickel. We may, therefore, use **magnetic force** to move objects made of these metals.
(e) Objects are capable of exerting one type of force — a force of attraction called **gravity**. Any two objects attract each other with this force. This force of attraction depends upon how heavy the objects are. It is only when at least one of them is very heavy — like the moon or the earth — that this force is appreciable. It is the earth's gravity that changes the motion of a ball thrown in the air. This force slows down the ball in its upward motion, brings it to a stop and then pulls it down.

You can get a feel for the strength

of this type of force by doing a simple experiment Keep an iron nail on the table. The iron nail is being pulled by the earth. But you, who are so much smaller than the earth, can lift the nail and beat the gravitational force of attraction between the earth and the nail. In other words, you have defeated the earth! A magnet can also lift the nail, which shows that the force exerted by the magnet on the nail is greater than the gravitational force exerted by the earth on the nail.

3.3 Friction

If you stop pedalling a bicycle, it begins to slow down and soon stops. The distance the bicycle would cover after you stop pedalling would depend upon how smooth the road is. If three children are riding their bicycles at the same speed on three different types of roads,

(**a**) a smooth cement road,

(**b**) a smooth gravel road, and

(**c**) a rough dirt road,

and stop pedalling at the same time, the distances the bicycles will cover before coming to a stop will be different On which road do you think the bicycle will travel farthest before stopping? And on which road will it travel the shortest distance?

In each of the above cases, the motion of the bicycle was **changed** by the road. We know already that force is needed to change the motion of an object. The road, therefore, must have exerted this force on the bicycle. This force is called **friction.** Friction depends upon the smoothness of the surfaces: different roads changed the motion of the bicycles to a different extent. Roll (**i**) a glass marble, (**ii**) a wooden ball, and (**iii**) a lemon, with the same force on the same road. The smooth marble will cover the longest distance before coming to a stop as the road offers the least friction to it.

3.4 Friction is a force

The force of friction **always** opposes the motion of objects and slows them down. If it can have its way, friction will prevent them from moving. For example, you need more effort to keep a load moving on a rough surface than on a smooth surface.

3.5 Control of friction

We can control friction — that is, increase it or decrease it — to some extent. We deliberately make the striking side of the match-box rough because we want more friction when the match is struck. Can you guess why? You will notice that **friction produces heat.** Rub your hands and you will feel the heat produced by

friction. And we **want** heat to be produced when we rub the match-stick against the box. If no heat were produced, the match-stick would not catch fire. When you pump air into a bicycle tyre, the friction between the moving air and the walls of the nozzle produces heat that warms up the nozzle. When a shooting star enters the earth's atmosphere, the friction between the shooting star and the air produces so much heat that the shooting star melts and evaporates. It appears bright only because its temperature becomes very high. Shooting stars are, therefore, not really stars. They are objects such as stones or rocks that have been accidentally pulled by earth's gravity into the earth's atmosphere.

If we wish to **reduce** friction, we make surfaces as smooth as possible. We spread fine powder on the carrom board to reduce friction between the coins and the board; we use **ball bearings** (that is, small, smooth steel balls) to reduce friction between the moving parts of a machine. When we oil the moving parts of a machine, like the axle of a pulley, a thin film of oil is formed between the moving parts Since such a film offers very little friction, the parts of the machine move very smoothly. Put a drop of oil on your forefinger and rub it with your thumb. See how easily the finger slips over the thumb. Using oil — that is, **lubrication** — is therefore a good way to reduce friction.

What would happen if you tried walking on a smooth floor smeared with oil? You might slip easily because the friction between your feet and the floor has been reduced. This should make you realise that **friction can also be useful**! It is the friction between the ground and your feet that enables you to walk. The toes enable you to get an even better grip on the ground by increasing the friction between the feet and the ground. That is why it is easier to walk barefooted on a slippery floor than with shoes on. It is friction that stops moving vehicles when we apply brakes.

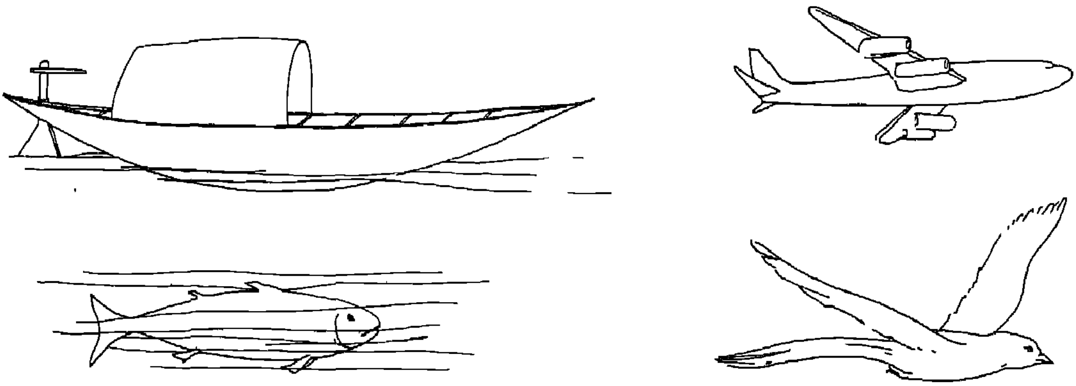
It is necessary to overcome the force of friction for any two objects to slide over one another. These objects could be solids, liquids or gases. Gases offer less friction than liquids, and liquids less friction than solids.

3.6 Streamlining

Every swimmer knows that he should never dive in water flat on his belly. When he dives, he lets his hands enter the water first, followed by the head. Water offers less resistance — that is, friction — to pointed objects than to flat ones. Those of

you who swim in the sea would know that if you let a breaker hit your chest, you run the risk of being knocked down. If you turn and take the breaker on your arms, you can let is pass harmlessly. Similarly, an arrow is fitted with a pointed tip so as to reduce the friction between the moving arrow and the air. You will find that it is easier to move a sheet of paper in air along its edges than across the full face of the sheet. Friction can, therefore, be reduced by reducing the surface of contact between objects in the direction of the motion.

We often design the shapes of objects in such a way that the friction between the object and the air (or water) is reduced in the direction of the motion. This process is called **streamlining**. These days most of the boats, cars, trains and aeroplanes are **streamlined**. It is, in fact, the streamlined shape of a fish that enables it to move so easily in water, and the streamlined shape of the birds that enables them to fly so gracefully in air. Do you see any similarity between (**i**) the shape of a boat and the shape of a fish, and (**ii**) the shape of an aeroplane and the shape of a bird (**P**4)?



PICTURE 4

We often desire an effect opposite to that of streamlining. For example, the sails of a sail-boat are often held in such a way that they offer their full area to the wind. We do not want the wind that moves the sail-boat to slip across the sails. So, as we want to make full use of the force of the wind to move the boat, we spread the sails out even though we streamline the boat.

3.7 Friction causes wear and tear

You have learnt that when two solid objects are rubbed together, they wear out. This happens due to friction. When you write on the board with a

chalk, the chalk wears out quicker than the board Can you say why? The evidence of the effect of the force of friction between two objects is seen more easily in the softer of the two objects.

You will indeed find many examples in everyday life where rubbing causes wear and tear. When sandpaper is used to make rough wood smooth, both the paper and the wood wear out.

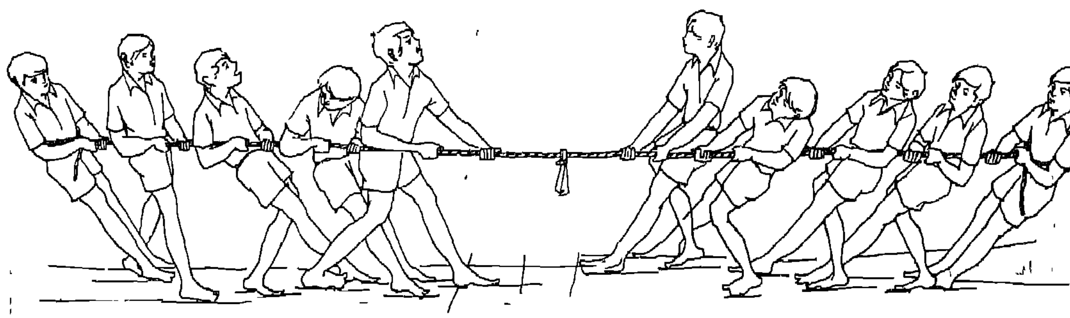
The wearing out of objects can also be useful. A turner uses a hard and sharp tool to wear out an object turned on a lathe to make it useful. In fact, he does his best to make the object wear out by friction as fast as he can!

To make things move smoothly, we use **lubricants** which reduce friction. Reduction of friction results in reduced wear and tear. Lubricants, therefore, are doubly useful; they make the motion smooth, and they reduce wear and tear.

3.8 Force is like an arrow

Let us suppose that we have to push a cart on a road. If only one man pushes the cart, he may find it hard. If, however, two or more people push the cart in the same direction, they will be able to push the cart more easily. They will also be able to push it faster.

What will happen if two people push the cart in opposite directions? They will cancel the effort of each other and the cart may not move at all. You will realise that in a tug-of-war (**P**5) sometimes the rope simply does not move, even though a lot of people are pulling it with all their strength. If one team is stronger than the other, this team is able to pull the rope on its side, and wins the match.



PICTURE 5

What do these examples show us?

(**a**) Forces applied at the same point in the **same direction add** to one another. The total force on the point is the sum of all the individual forces acting on it separately. Ants, too, seem to know this! Have you seen a big

team of ants working together to carry a 'big' load? Each ant finds it easier to push the load if other ants are helping.

(b) If two forces act at the same point in **opposite directions**, the net force on the point is the **difference** between the two forces. Look at the game of tug-of-war in picture **P5**. The force applied by one team on the rope is opposed by that of the other team. The net force on the rope is the difference of the forces applied by the two sides. If both the teams apply equal forces, the rope does not move at all. But if one team applies greater force than the other, it wins the game.

You will realise now that in order to describe a force it is necessary to:

(i) give its size or the **magnitude,** and

(ii) to specify the **direction** in which the force is acting.

We can, therefore, describe a force by an arrow. The length of the arrow would be equal to the **magnitude** of the force. The direction of the arrow would show the direction in which the force acts.

3.9 Force will not leave you alone!

When we roll a ball on a smooth surface, we apply a force to the ball and then let it go. Due to this force the ball begins to move with some speed. The force of friction between the ball and the surface opposes the motion of the ball. The ball, therefore, loses speed and eventually stops.

If the surface is **very smooth,** — that is, the force of friction is **very small** — it will take a longer time for the ball to come to a stop. During this time, the ball will cover a longer distance.

3.10 Force can cause a change in direction

You have seen that the effect of a force on an object is to change the motion of the object. The change of motion can be brought about in three ways.

(i) You may change the **speed** of the object; or

(ii) You may change the **direction** in which the object is moving; or

(iii) You may change **both the speed and the direction.**

When you tie one end of a rope to a stone and hurl it around by holding the other end of the rope, you are applying a force. As a result of this force, the stone begins to move faster and faster in a circle around you till it reaches a certain speed. You will find that if you want the stone to keep moving with the **same** speed, you have to keep on applying the force. What is

the applied force doing now, if it does not increase the speed of the stone?

Remember that you are moving the stone in a circle. This means that you are changing the **direction** of motion of the stone **all the time**. A change in the direction of motion means a change in motion, and force is needed to change motion. Moreover, the friction between the air and the moving stone tends to slow down the stone. You have to keep on exerting force to overcome the force of friction as well. The force you apply to keep the stone moving in a circle at the same speed, therefore, does two things. Most of the force is utilized to change the direction of motion; a small part of the force is utilized to overcome friction due to air.

3.11 Force can change the shape of an object

When an object is not free to move, the applied force **deforms** it, that is, it changes the shape of the object. If the object is soft, we can see the deformation easily. For example, when you squeeze a balloon, dough or a lump of wax, you can easily deform it. Let us study a special case of deformation

Take a spring. (If you do not have a spring you can make one very easily by winding a wire tightly around a pencil.) Tie one end of the spring to a hook on the wall or to a stand, if one is available. To the other end of the spring tie a pan made out of the lid of a tin. Measure the length of the spring.

Now put one marble in the pan. You will notice that the spring is stretched, that is, it has become longer. Measure the length of the spring. Now put two marbles in the pan and again measure the length of the spring. You may go on doing it until you feel that it is no longer safe to add more weight to the spring. Can you tell why you feel it is no longer safe to add any more marbles now? The reason obviously is that every spring has its limit. A hard spring can support more weight than a soft one.

You can now make a table showing the number of marbles in the pan in one column and the length of the spring in another column. Now put a counted number of nut-bolts in the pan and measure the length of the spring. Can you now say how many marbles are equal to one nut-bolt?

When you put a marble in the pan, the weight of the marble acted upon the spring. **Weight is a force**. The force of weight deformed — that is, stretched — the spring. We have made use of the fact that a spring can be stretched by a force to make a spring balance.

In everyday practice, we wish to know the weight of an object in grams or kilograms and not in terms of marbles. Further, it is cumbersome to measure the length of the spring every time we use it. We can overcome both these problems by:

(i) fixing the spring on a wooden board,
(ii) calibrating the spring with standard weights instead of marbles, exactly in the manner we did in the above experiment;
(iii) attaching a pointer to the end of the spring; and
(iv) marking the places where the pointer comes to rest when different standard weights are put in the pan.

You may like to look at a spring balance more closely. The spring balance measures the weight of an object. The weight of an object is the pull — that is, the force of gravity — that the earth exerts on the object. We can, therefore, say that the spring balance measures force.

You may, if you wish, repeat the above experiment using a rubber band in place of the spring.

3.12 Periodic motion and clocks

We have already seen that some motions are periodic, that is, they are repetitive and regular. It is easy to see that such motions can be used to mark time intervals, that is, to measure time.

Nature provides us with some periodic motions. The day and the night, the lengthening and the shortening of shadows, the phases of the moon, the tides of the sea and the onset of seasons are events that occur again and again, and regularly. For thousands of years, man has been making use of these events to mark time intervals, that is, to measure time **Motion and time are, in fact, always related.**

You have already made a list of objects that exhibit periodic motion. Let us study the periodic motion of one of these objects — the pendulum — in some detail.

You can make a simple pendulum by tying a weight (a bob or a stone) to one end of a strong string about one metre long, and then tying the other end to a hook on the wall. Make sure that the pendulum does not touch the wall anywhere. Now gently swing the pendulum. The pendulum completes one swing when, starting from one extreme position (say left), the pendulum goes to the right and comes back again to the extreme left. Take the help of a friend, and find out the time taken by the pendulum to

complete 50 swings. (Remember it takes nearly one second to say 'Brahmaputra' or 'Tungabhadra'.) Can you now calculate how much time it takes for the pendulum to complete **one** swing?

You will find that if you do not change the length of the string, the time taken by the pendulum to complete one swing (that is, **oscillation**) is constant. The swing may be large or small, the stone may be light or heavy, but the time taken for one swing will surprisingly be the same.

Now reduce the length of the pendulum to nearly 50 cm and repeat the experiment What do you find? Is the time taken for one swing the same as before?

The property of the pendulum, that one swing always takes the same time, is made use of in a pendulum clock. The motion of the pendulum has given us a device that measures time intervals.

3.13 Pressure

When you wish to drive a nail in a block of wood, you apply force on the head of the nail with a hammer. As a result of the applied force, the pointed end of the nail is driven into the block of wood.

Take two nails of the same size, one with a pointed end and the other with a blunt end. If you hammer with the same force on the head of each nail, you would find that the pointed nail is able to pierce the wood easily, while the blunt nail is unable to do so.

In the case of the nail with the pointed end, all the force applied was concentrated on a small area, that is, on the point of the tip. In the case of the blunt nail, the same force was spread over the larger area of the blunt end. Force divided by the area on which it is spread — or **acts** — is called **pressure.**

Area remaining unchanged, pressure on it increases with increase in force. Pressure also increases if the force remains unchanged but the area decreases.

The nail with the pointed tip could be driven into the wood easily in the above experiment because the force applied was concentrated on a small area, that is, the pressure was high. The blunt nail could not be driven into the wood because the same force was now spread over a larger area resulting in a lower pressure.

A pin, a hack, a nail and the tip of a root are all pointed. A knife, a blade or the cutting edges of a pair of scissors are all sharp. Can you now see why?

4. ACTIVITIES

4.1 Observe a few moving objects. Estimate the distance covered by each of them in a minute. Make a list of these objects in increasing order of the distance covered by them in one minute. Present the results to your class.

4.2 Estimate the distance between your school and your home, and find out how much time you normally take to walk this distance. Now calculate the distance covered by you in one minute. This distance would give you the **speed** at which you walk.

Speed = Distance/Time

4.3 Measure the length of your school playground and find out the time you would take to run from one end of the ground to the other. Now calculate your speed of running. Compare this speed with your speed of walking. Compare both these speeds with your speed while walking **backward.**

4.4 Ask your friend to stand about a hundred metres away from you with a gong and a hammer. When he strikes the gong with the hammer, observe carefully whether you hear the sound first or see the hammer strike the gong first. From this experiment can you say which moves faster, sound or light?

4.5 Gently roll a marble from one end of the table towards the other, and find out the time it takes to reach the other end. Measure the length of the table using your scale. Calculate the speed of the marble.

4.6 Mark a point (by sticking a small piece of paper) near the edge of a potter's wheel or a gramophone record and find out the time taken by the wheel (or the record) to complete 100 rotations. Calculate the number of rotations in one minute.

4.7 Find out the maximum distance from which you can move a pin, a nail and a 25 paisa coin (minted between 1946 and 1971) using a magnet. Compare the distances. What conclusions can you draw from this experiment?

4.8 With a piece of chalk write on the blackboard, on the top of your table, and on a sheet of glass. In which case do you find it easiest to write? Explain why. What changes occur in the chalk in each case? Are these changes different in the three cases? If so, in what way?

4.9 With the help of a spring balance, find out the minimum force required to move a wooden block

placed on a sheet of glass, or on a table, or on a sandy ground. Compare the forces and arrange the surfaces in the increasing order of the friction offered by them. Ask your teacher to help you with this experiment.

4.10 Make a balance for measuring force, using a rubber band or an elastic string instead of a spring. Calibrate the balance in units of weight of 10 paisa coins. Use this balance to find the weight of a match-box, a marble and a grain of wheat.

4.11 Try pushing a wooden block, the head side of a nail, a pencil and a drawing pin through a bunch of papers. Use a hammer to push the above objects and try to give a blow on the hammer with as equal a force as possible in each case. Can you now say which object exerted the largest pressure on the bunch of papers, and which object the smallest?

4.12 Take two pieces of unpolished stone and rub them against each other in a dark room. What do you observe? Can you explain why the sparks are produced?

Observe what happens when a knife or a pair of scissors is sharpened on a grinding wheel.

4.13 Cut a 10 cm long, 10 cm wide and 2 mm thick piece of wood. Pierce about 10 cm long nails at each corner of the piece of wood so that 5 cm of each nail remains on either side of the wood. Ensure that the pointed ends of all the four nails are on the same side. Place this instrument on a levelled sand surface and gently place a 100 g weight on the piece of wood. Measure the length to which the nails sink in the sand. Turn the instrument upside down so that the heads of the nails now support the piece of wood. Again place the 100 g weight on the piece of wood and measure again the length to which the nails now sink in the sand. Explain why the extent to which the nails sink is different in the two cases.

4.14 Organize a race between an ant and a bedbug or an earthworm You may find that keeping them in track is not easy. Think of a suitable way to find out the distances covered by them in a given interval of time. Can you say which of the two animals you used moves faster?

4.15 Organize a tug-of-war between two teams made from your class.

4.16 Organize the following race between your classmates. When the teacher blows the first whistle, all participants should start running from the base line. When the teacher blows the second whistle, all participants should turn around and run **towards** the base line. Guess before you start, who will win the race.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

We observe motion all around us. The motion of objects may be of different types: translational, rotational, oscillatory, vibrational, or a combination of one or more of these types.

Force causes a change in the motion of objects. This change can be of three types. (i) the speed of the object may be changed; (ii) the direction of movement may be changed; or (iii) both the speed and the direction may be changed.

We should remember that to bring about a change in the motion of an object, a force is **absolutely necessary**. If there is no force acting on the object, there will be no change in its motion. If there is no change in the motion of an object, we may conclude that **no net force** is acting upon it.

We have seen that the effect of a force is a change in motion. Whenever we see a change in motion, we know that some force must be causing that change. In many cases we can find out easily what force is causing the change. In many other cases, we see a change in motion but cannot easily 'see' the force responsible for the change. Sometimes the force is created within the object (for example, the force exerted by muscles) and is not at all obvious.

There are some forces that we can easily control, while there are others that we cannot. However, the forces that we cannot control are not always undesirable. For example, the force of gravity (over which we have no control at all) helps us to stand, and the force of wind and of water can be used to produce electricity. At times, of course, such forces produce undesirable effects. For example, the strong winds carry away with them the upper layers of soil from which plants draw some of their food. We often experience a strong wind upturning our umbrella; sometimes, wind uproots even trees and electric poles.

The weight of an object on earth (or on any other planet) is entirely due to the force of gravity of the earth (or the planet). Weight is, therefore, a force; that is why we are uncomfortable when we carry heavy loads. If there were only one object in the whole universe, it would have no weight as there would be no other object to pull it!

We have also learnt that friction is

a force The force of friction always opposes the motion of an object. Sometimes we wish to increase the force of friction. At other times we wish to reduce it. We can increase the force of friction by increasing the roughness of the two surfaces which are in contact. We can decrease the force of friction by using suitable lubricants, or by reducing the area of contact.

Force may also change the **shape** of an object. This property can be used to measure force, as in a spring balance.

The effect of force on an object may be conveniently increased by applying it through a small area. For example, we make it easier to push a nail through an object by increasing the sharpness (that is, decreasing the area) of its tip. Force divided by the area on which it acts is called pressure.

We know that our body is capable of exerting only a limited amount of force. We often require large forces — much more than can be exerted by even the strongest man on earth — to change the motion or the shape of objects. Can you think of a few occasions where such large forces are required? (One example would be : to pull a train.) For producing large forces we make use of machines about which you would learn in the next chapter.

We should realize that many natural forces are very very large. Have you seen a wind uproot a large tree? It would, therefore, be wise for us to learn to make use of such large natural forces for the benefit of man Can you think of a way in which this can be done?

We have also learnt that a force has both magnitude and direction. Forces can thus cooperate with, or oppose, each other. When they cooperate, they are more effective. Is there a lesson in this for us?

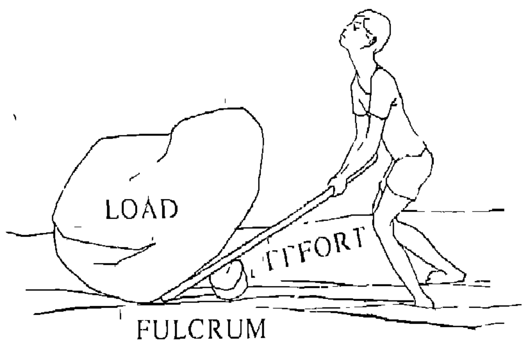
CHAPTER 6

SIMPLE MACHINES

1. OBSERVATIONS

1.1 You would have observed people doing different kinds of jobs. Sometimes they do the job entirely with their own hands, as **you** do when you carry your books to school in your hands. Very often, however, people use machines to help them do a job. Many jobs would be very difficult without machines. Many other jobs, even though not so difficult, are made much easier by simple machines. Let us look at some examples.

(**a**) If a very heavy stone is to be removed from the field, we often use a long iron bar to do the job. We call this bar a **crowbar** (**P**1).



PICTURE 1

(**b**) If a tin has been closed too tight, we insert the handle of a spoon between the lid and the edge of the tin and press the other end of the spoon; the lid then comes off easily (**P2**).

PICTURE 2

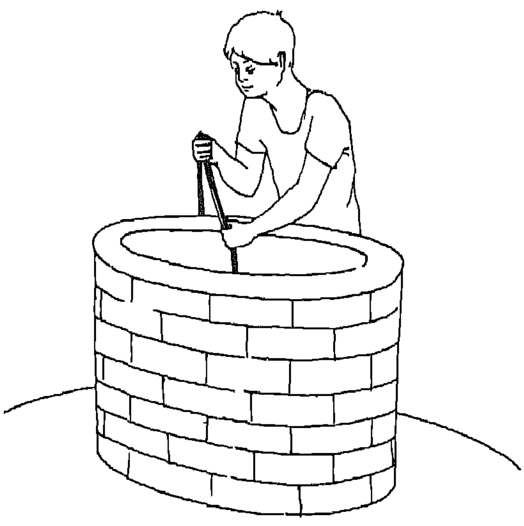
What do you think would happen if you used your fingernails instead?

(**c**) What does an ironsmith do when he wants to hammer a very hot piece of iron to give it a particular shape? How does he handle the hot iron? He uses a pair of tongs (**P**3).

(**d**) See the two pictures **P**4a and

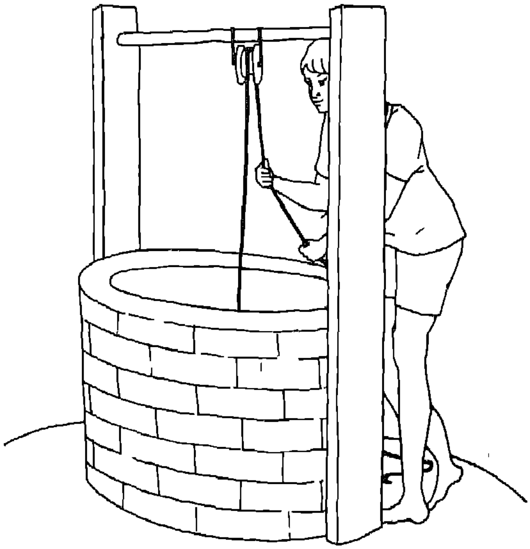
PICTURE 3

P4b. In **P**4a, the young boy is pulling the bucket straight up from the well. Pulling the rope upwards this way is quite tiring. He would have found it much easier to pass the rope over a **pulley** and then pull the end of the rope in his hands **downwards**, as the other boy in **P**4b is doing.



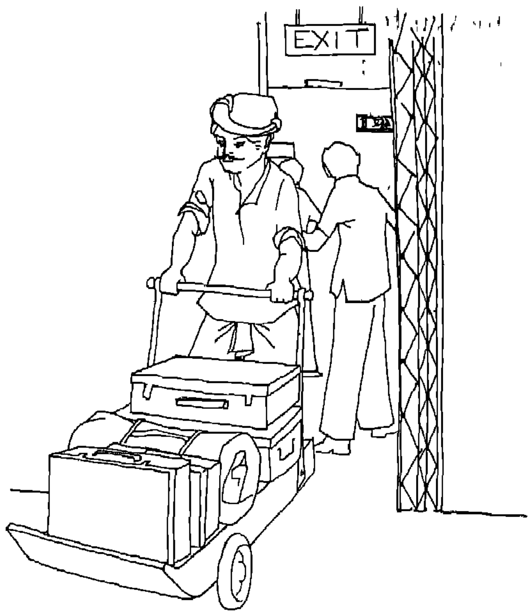
PICTURE 4a

(**e**) Very often we wish to move a heavy load from one place to another.



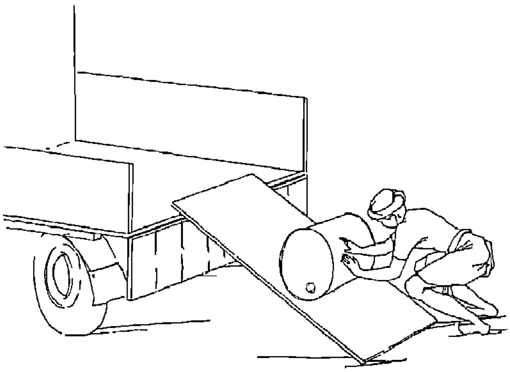
PICTURE 4b

Pushing a heavy object directly is not easy. If, however, we put the heavy object on a platform on **wheels**, we find it much easier to push the platform with the load on it (**P**5).



PICTURE 5

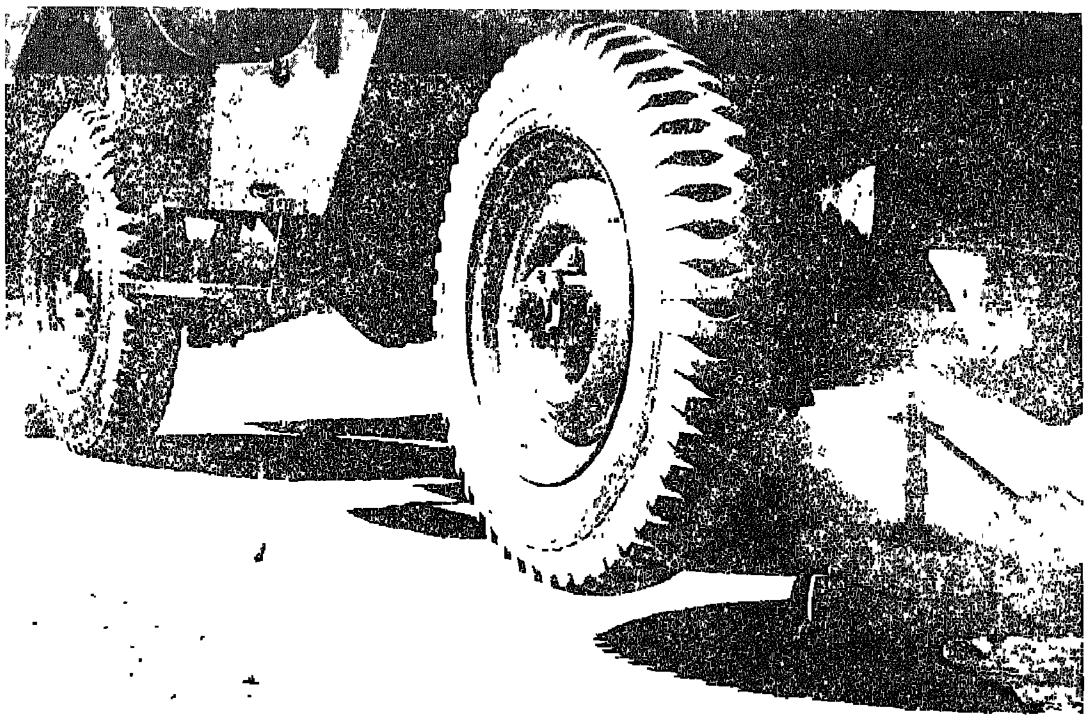
(f) How do we place a full drum of oil on a bullock cart? Lifting the drum and putting it into the cart will not be easy. Do you think the man in the picture below (P6) is doing it more easily?



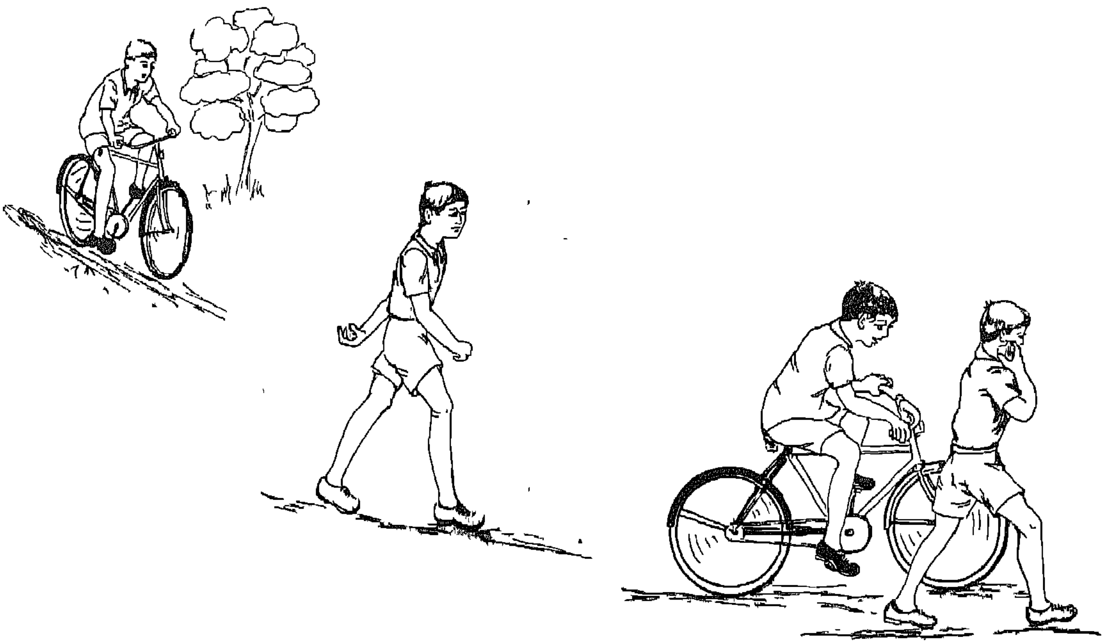
PICTURE 6

1.2 There are indeed many instances we come across in our daily life where the work will be totally beyond our ability to do, but for the help from **simple machines**. Let us look at some more examples.

(a) Can you suggest a simple way of turning a railway engine around? How many people do you think will be needed to lift it and place it back on the track after turning it around? We can, of course, be cleverer and lay a circular track. Then we can turn it around by continuing to drive in the same direction. But how much space and track will be needed to turn the



PICTURE 7



PICTURE 8

engine around in this manner? Visit a loco-shed and see how easily one man can turn the engine around with the help of a turntable.

(**b**) In picture **P**7, a man is changing a tyre of his car. He is using a **jack** to lift the car. How many people would be needed to lift the car and to keep it lifted if he did not use the jack? Do you think he could do this job single-handed if he didn't have a jack?

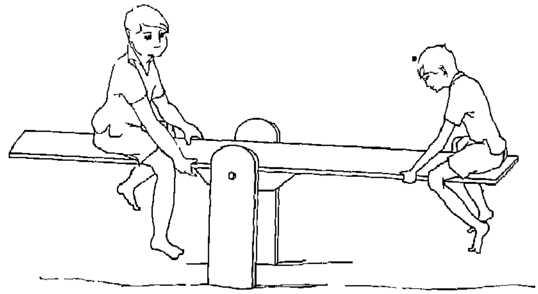
(c) A **crane** is used for lifting very heavy loads. Can you give examples where this method of lifting loads may help man?

(**d**) Two boys start out from the same point, one on foot and the other, an hour later, on a bicycle. They meet after a while (**P**8). The boy who has walked looks tired, while the boy riding a bicycle does not. Why do you think the boy on the bicycle is not tired, even though he has covered the **same** distance more quickly?

(**e**) Often, we push the cork of a bottle well into the bottle to keep it tightly closed. Sometimes we have great trouble getting the cork out! Don't you admire the boy in picture **P**9 who is using a screw to pull the cork out?

(**f**) How is it that the thin and small **child** in picture **P**10 is able to lift the hefty boy on the **see-saw**?

Picture 9



Picture 10

2. QUESTIONS

We have seen a number of instances where difficult jobs could be done quite easily by using simple machines. How do machines make so many jobs so much easier for us?

How could we shift such a heavy stone on the field without using much force (**P**1)?

Why was it easy to open the lid of the tin with the help of a spoon (**P2**)?

How does a pulley help in making our task of drawing water from a well simpler (**P**4b)?

Why was it easier to push the barrel on the tilted (inclined) wooden plank (**P**6)?

How do wheels help in moving objects (**P**5)?

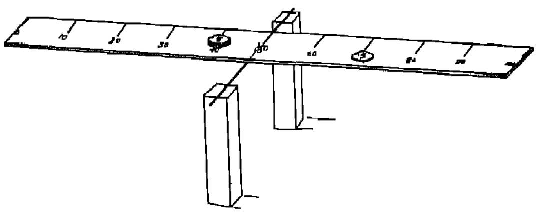
How does a screw help in opening corked bottles (**P9**)?

3. LET US FIND OUT

3.1 Balancing and lifting feats

You must have played on the see-saw. You know that it is possible for a small boy to balance a heavier friend on the see-saw if he sits **away** from the centre and asks the friend to sit **near** the centre. Let us do some simple experiments to find out the secret of this balancing feat (**P**11)!

Take a metre scale with a flat hook attached in the middle. Pass a thin rod through the hook and suspend the metre scale on two blocks as shown in picture **P**11. If the metre scale does not balance, use some plasticine (or molten candle wax) to balance the scale.



PICTURE 11

Usually coins of the same denomination have approximately the same weight. Use a number of coins (say 5 paisa coins) to conduct the following experiments, and fill in the blanks in the given table. (Make sure that your scale is balanced, each time, you record your observations in the blank spaces.)

EXPERIMENT

Put the following on the left-hand side of the scale	*Find out what you need to balance the scale on the right-hand side and record your observations in the blank spaces provided below.*
1. One coin at a distance of 10 cm from the centre	One coin at a distance of — cm from the centre
2 Two coins, one over the other, at a distance of 10 cm from the centre	(**a**) One coin at a distance of — cm from the centre or (**b**) Two coins, one over the other, at a distance of — cm from the centre
3 One coin at a distance of 5 cm and one coin at a distance of 10 cm from the centre	(**a**) One coin at a distance of — cm from the centre or (**b**) Two coins, one over the other, at a distance of — cm from the centre

The experiment shows that the ability of a coin to tilt the scale depends upon **how far it is placed from the centre**

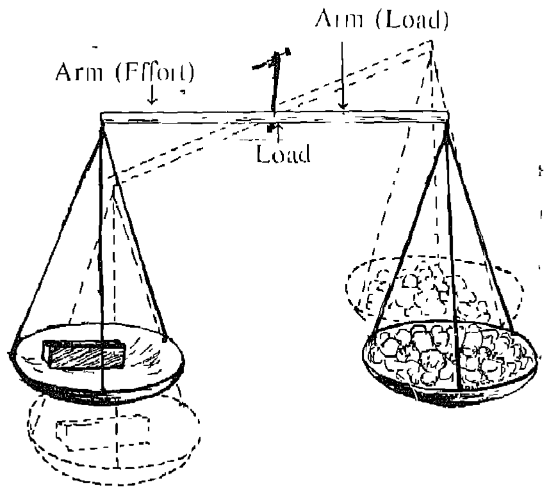
When one coin was placed at a distance of 5 cm and another at a distance of 10 cm on the same side, we could balance the metre scale by placing on the other side either one coin at a distance of $5 + 10 = 15$ cm, or two coins at a distance of $15/2 = 7.5$ cm. A smaller number of coins placed farther from the centre can balance a larger number of coins placed nearer the centre.

The coin has weight. It is the weight of the coin that turns the metre scale around the point at which the scale is supported. Such a point of support is called the **fulcrum.**

You should now be able to understand why the crowbar is useful for shifting heavy loads. The load is close to the fulcrum. The **effort**, that is the force applied to shift the **load**, is much further away from the fulcrum. You need to apply much less force than the weight of the stone to raise it upwards. A small force applied at a point far away from the fulcrum can move a large load placed near the fulcrum.

Can you now explain why a spoon is useful in opening the lid of a can? Where do you think is the fulcrum in this case?

When we wish to compare the weights of two objects, we deliberately make the two distances from the fulcrum equal. A **beam balance**, shown in picture **P12**, is a device to compare the weights of two objects. In a beam balance, the two **arms** are equally long. If the two objects placed in the two pans are of equal weight, they will try to turn the arms of the balance around the fulcrum with equal force but in opposite directions; the beam will, therefore, remain stationary — that is, it will not move.



PICTURE 12

Remember that in a beam balance, we only compare the weights of two objects. A beam balance will, therefore, remain balanced even if we take two objects of equal weight to the moon (where the force of gravity is only one-sixth that of the earth), and put one object on each pan. You

should now be able to answer the following questions.

If a brass object weighs 6 kg on earth on a spring balance, how much will it be found to weigh on the moon, (i) if we use a beam balance, and (ii) if we use a spring balance?

3.2 A matter of safety

You have seen how tongs can be used to handle hot or burning objects such as a hot piece of coal. Here the problem is not to lift something heavy; the problem is to handle a dangerously hot piece of coal. For this purpose, obviously, the piece of coal should always be further **away** from the fulcrum than the point where we apply force. The force we will have to apply will, therefore, be more than the weight of the piece of coal. But in such cases, we usually do not mind applying a little more force since we gain in another way: the use of tongs makes it **safe** for us to handle the object.

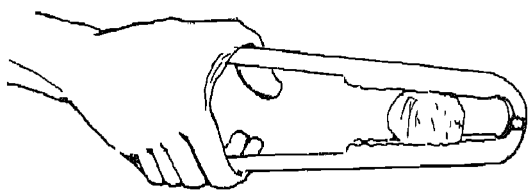
3.3 Levers

In many of the cases listed above, we used a device to lift a load by applying a force **somewhere else**. Such devices are called **levers**. We found that we could use different types of levers in different situations. Let us look at them again.

(**a**) In the first type of lever, the fulcrum is in between the load and the effort, and the distance between the load and the fulcrum is always less than that between the effort and the fulcrum. This type of lever gives us an advantage as it considerably reduces the effort we have to put in to do the job. The crowbar in picture **P**1 is an example of this type of lever.

(**b**) In the second type of lever, the fulcrum is exactly at the centre. A beam balance (**P**12) is an example of this type of lever. Here the load exactly matches the effort

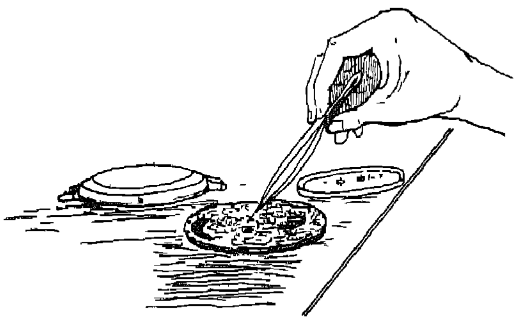
(**c**) In the third type of lever, the fulcrum is at one end of the lever, and the effort is always farther from the fulcrum than the load is This type of lever also reduces the effort that we have to put in to do the job. A nutcracker (**P**13) is an example of this type of lever.



PICTURE 13

(**d**) In the fourth type of lever as well, the fulcrum is at one end. However, in contrast to the nutcracker, the effort in this type of lever is closer to the fulcrum while the load is away from the fulcrum. No

advantage is gained in this kind of lever as far as the force applied is concerned, but it is very useful for lifting tiny objects (**P**14) or objects that cannot be touched by hand, such as a burning coal (**P**3)



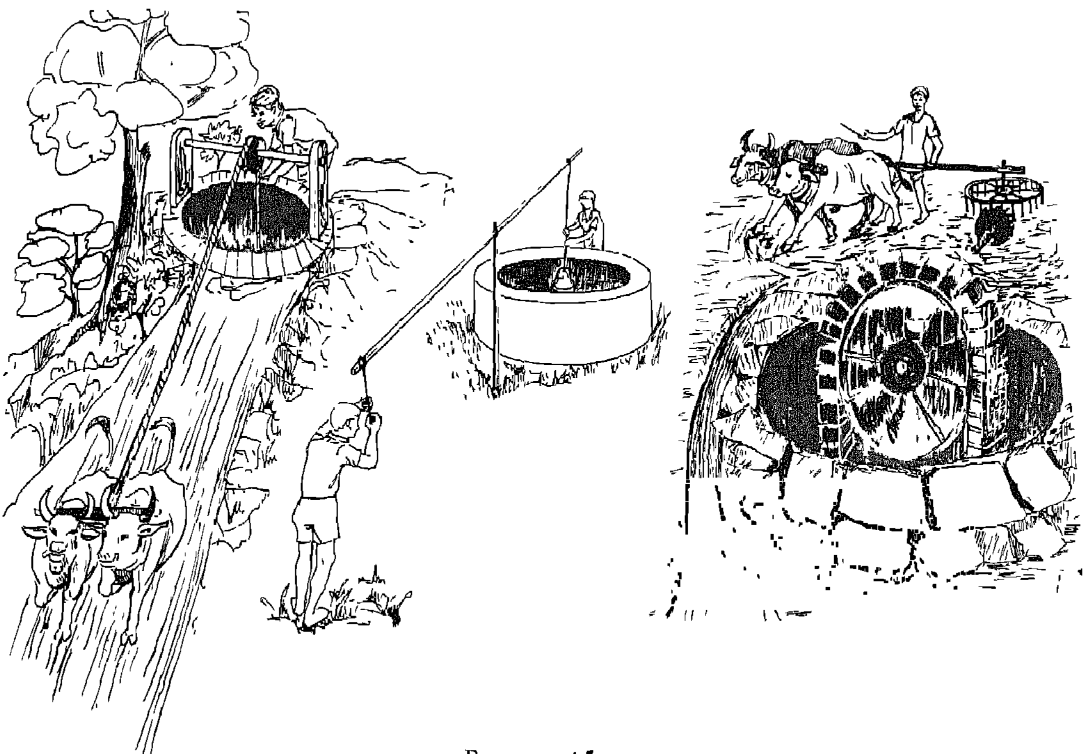
PICTURE 14

Many parts of our body operate on the principle of lever. Can you name some of these parts?

3.4 Pulley

In pictures **P**4a and **P**4b, we saw two boys drawing water from the well. We found that it is more comfortable to pull the rope **downwards** (as in **P**4b) than to pull it **upwards** (as in **P**4a). The force required is the same in both the cases. The pulley merely enables us to **change the direction** of the applied force.

The picture below (**P**15) shows several other useful ways of drawing water from a well.

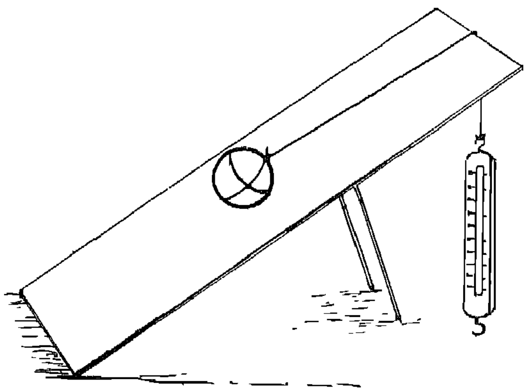


PICTURE 15

3.5 Inclined plane

When a load is to be raised, it is simpler to push it along an inclined plane. Let us find out how much simpler it is!

Using a spring balance, find out the weight of a ball. Now place the ball on an inclined plane as shown in picture **P**16. See how much weight is needed on the spring balance to support the ball on the inclined plane (that is, to prevent it from slipping down).



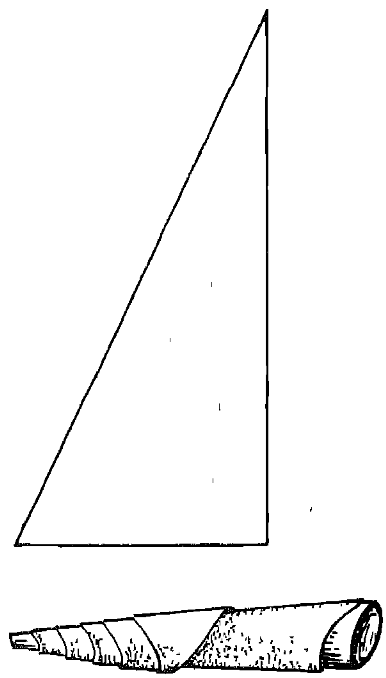
PICTURE 16

Change the angle of the inclined plane and see how the weight needed to support the ball changes. Do you find that you need more weights at greater angles? You will also recall from everyday experience that it becomes increasingly tiring to walk on a slope as it becomes steeper. Are these two experiences related? From these observations, can you now say why is it easier to push an object up an inclined plane than to lift it straight up to the same height? Do you now see why the man in picture **P6** used the plank of wood?

3.6 Screw

You will find that driving a screw into a block of wood by simply turning it with a screw driver is much simpler than hammering it with a hammer. If you now wish to pull the screw out, you will notice that it cannot be pulled out as easily as a nail can be pulled out.

A simple experiment will show why it is difficult to pull out a screw. Drive a screw up to just a few threads in a soft cork, using a screw driver. Now



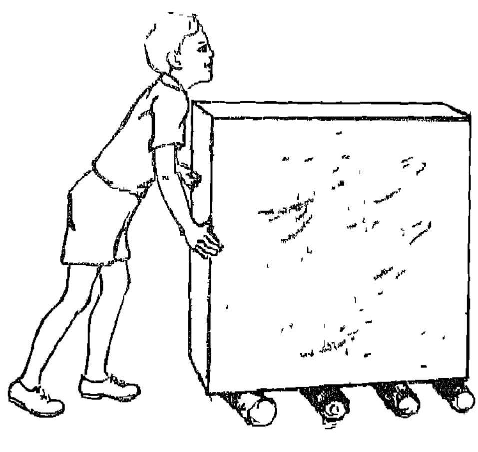
PICTURE 17

try pulling it out. If you succeed, you will find that a portion of the cork around the screw is torn out. You should now see why a well-driven screw in a firm and hard material can support a considerable amount of weight. If you look around, you will find that we use this property of a screw all the time.

Look at the picture (**P** 17) on page 79. It shows how a screw can be obtained **from an inclined plane** by simply winding the inclined plane around its height

3.7 Wheel

If we wish to push a load, we find that pushing it on wheels is always easier. When a very heavy load is to be moved, cylindrical logs are often pushed under the load; the load can then be easily pulled over the logs (**P** 18).



PICTURE 18

It is not surprising, therefore, that all our vehicles move on wheels. The wheel is one of the earliest and also one of the most important inventions of man.

If wheels are so convenient for moving loads, why don't we put wheels under our feet? Can you say what would happen if our feet did have wheels? If you think, you would find that the disadvantages would be far more than the advantages.

3.8 Simple machines

We have learnt that a machine is a device for getting a job done by applying a force at a convenient point. We use many machines in our daily life. You have learnt about some of them. Some others are the sewing machine, a pair of scissors and a water pump.

If you examine these machines in detail, you will find that they are made of different combinations of the **simple machines** we have studied, that is, of

(i) Lever,
(ii) Wheel,
(iii) Pulley,
(iv) Inclined plane,
(v) Screw.

These five simple machines are the letters of an alphabet, out of which more complex machines are made — just as A, B, C. . . . , are the

letters of the alphabet out of which words are made in the English language. The screw-jack is a two-letter word in the language of machines, and the two letters are **screw** and **lever**!

Examine your bicycle and sewing machine carefully and see how many simple machines you can identify in them.

3.9 Care and use of machines

If we wish to use machines to save labour and to make our lives comfortable, we must take proper care of the machines.

We have already learnt that friction opposes motion and that lubrication reduces friction. We should, therefore, lubricate the moving parts of a machine. Oiling the axle of the pulley will reduce friction and make the task of drawing water from the well easier.

We should keep the machines clean and store them properly when they are not in use. Many parts of machines are made of iron and can rust; we can prevent them from rusting by painting them. In this way, we can prolong the life of the machines.

In spite of the fact that machines simplify our work, we find that machines are not used as commonly as they should be. For example, in many villages people still draw water from the well the hard way, as in picture **P4a**. A system of pulleys can be installed at a very low cost, and will help the entire community You will similarly find that if brooms are fitted with long sticks, you can use them more conveniently without having to bend down.

A wheel barrow is another very useful device. It is simply a big metal basket mounted on wheels. It is so much more convenient to load the basket and to wheel it away than to carry the load on the head. Wheel barrows are easy to make and can be made in every village at very little cost.

3.10 A matter of convenience

In practice, we find that applying a small force is possible and within our capability. We can apply a small force for a long time without getting tired. However, applying a large force is often beyond our capacity; even if we are able to apply it, we get tired very soon. Pedalling a bicycle on a level road for one hour does not tire us as much as pedalling it on a steep road for fifteen minutes.

You may now be able to see why a **Ghat** road is built like a screw (**P**19). A screw is just a continuous inclined plane, but with a **small** angle. A **straight** road from the bottom to the

top of the hill will be an inclined plane with a **large** angle. The straight road up will, therefore, be much steeper. As you know, it becomes more and more tiresome to go up as the slope becomes steeper. That is why the **Ghat** road is built with a small angle. Going up the winding road is more convenient and less tiring than it would be if the road were to go straight up The energy spent in going up by either road would be the same, but in going by the **Ghat** road you would spend the energy at a slower pace.

You would see that all machines merely make our work simpler, easier and more convenient. They do not do any work on their own, nor do they do more work than the effort put in by us. **In fact, they do less work as some of the effort we put in is lost in overcoming friction**. For example, to

PICTURE 19

lift the stone through a small height, the man in picture **P**1 has to push the other end of the crowbar through a much **larger** distance. What would be the length of the inclined plane necessary to raise a barrel through one metre? You will find that it is always **more** than one metre. In a see-saw the lighter boy moves through a **larger** distance than the heavier boy. Yet in every case, we would have found it more difficult to do the job without the machine we used.

4. ACTIVITIES

4.1 Try to lift a heavy rock or a log of wood using a long bar.

4.2 Make a beam balance using a thin stick of uniform thickness.

4.3 Fix a pulley at a convenient height and use it to lift a piece of stone. Measure, with a spring balance, the weight required to lift the stone when you use the pulley. Compare this with the weight of the stone. Do you find a difference? What does this difference show?

4.4 Prepare an inclined plane using a wooden plank and a pile of books. Pull a load, say, a block of wood, up the inclined plane using a spring balance. Record the force (weight) required to pull the load to the top of the inclined

plane. Repeat the experiment for different angles of the inclined plane. Is the force required the same for all angles? Compare this force with the force (weight) required to lift the load vertically from the ground to the top of the inclined plane.

4.5 Cut out a right-angle triangle from a sheet of paper. Wrap it on a cylinder (say, a pencil) keeping the shorter side of the triangle along the axis of the cylinder Compare the pattern formed by the hypotenuse of the triangle with the thread of a screw. Can you now explain why a screw is called a modified form of an inclined plane?

4.6 Prepare a list of the devices used in your locality, which work on the principle of one or more simple machines we have talked about in this chapter. Identify the simple machines used in each of these devices. Compare your list with those prepared by your classmates.

4.7 Build a model of a crane, using any material you like.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 What are machines and why do we use them?

We have learnt that a machine is a device which makes it easier or more convenient for us to do a job.

Machines do not work on their own. To work, they always need an effort from an outside agent, such as man, water, wind or electricity. The work done by the agent on the machine is always more than the work done by the machine. Why, then, do we use machines? We use them because they help us in many other ways. The main advantages of machines are the following:

(i) It is not always possible for us to apply a force where it is needed. Machines allow us to apply the force at a convenient point. They then transmit the force to the point where it is needed.

(ii) Machines can increase the effect of a force, a small force applied by us can thus be used to overcome a large force. For example, when we use a crowbar, the force we apply is small, but it overcomes the force of a large and heavy stone. Similarly, when you fix a

screw with a screw driver into wood, you are overcoming a large force of friction of the wood by applying a small force. The inclined plane and the wheel are other examples of machines which help us to overcome large forces.

(iii) Machines allow us to do certain jobs which are otherwise unsafe or dangerous.

For example, the force required to pick up a small piece of hot coal is very small. Even a three-year old child can exert that force 'But we just cannot afford to pick up burning coal with our hands. We can, however, do so with a pair of tongs or forceps.

(iv) Machines can be used to change the direction of the force, to one that is convenient for us. For example, when we draw water from a well using a pulley, we apply force in the **downward** direction by pulling the rope downward. The bucket, however, is pulled up; clearly, there is an upward force acting on it. The pulley changes the direction of the force we apply on the rope.

5.2 The alphabet of machines

We have learnt that there are five kinds of simple machines. They are known as lever, pulley, inclined plane, screw and wheel.

Lever is a rigid bar which can rotate about a point known as the fulcrum. The position of the fulcrum in a lever may be either between the point where the effort is applied and the point where the load is applied, or on either side of these two points. The beam balance is a special kind of lever in which the fulcrum is exactly at the centre of the lever.

Pulley is a small wheel fixed on an axle about which it can rotate. It is used to change the direction of the applied force.

Inclined plane is a simple machine which helps to lift an object by applying a force less than the weight of the object.

Screw is a modified form of an inclined plane.

Wheel helps us to move objects with very little effort.

5.3 The words

We have learnt that all machines are a combination of one or more of the above five simple machines. For example, a screw jack is a combination of a screw and a lever. A hand-operated crane is a combination of a

pulley, a wheel and a lever. Such combinations allow us to construct a vast variety of machines which can perform a large number of different functions.

5.4 Take care of the alphabet and the words!

We have also learnt that if we want to get the best out of our machines, we must take proper care of them

THE UNIVERSE

1. OBSERVATIONS

Man has been observing the sky for thousands of years. You too must have looked at the sky many a time. By simply looking at the sky during the day and at night, we can observe many objects and quite a few events taking place in the sky. Let us list what we all can see easily.

1.1 **(a)** We see the **sun** during the day and the **stars and planets** at night. About 3000 stars are visible to our eyes. We see the **moon** mostly at night, though sometimes it is visible during the day as well. Occasionally, we see a **comet**. When a comet is visible, it can be seen just before sunrise on the eastern horizon or just after sunset on the western horizon. On a clear moonless night, we often see 'shooting stars'. If you observe carefully you can see at least one shooting star every night.

These days, we can also see **satellites** sent up by man. A satellite is often seen late in the evening. It moves fast and can be seen easily against the steady background of slow-moving stars and planets.

(b) Most of the heavenly objects appear to move. They generally seem to move from east to west, that is, they rise in the eastern part of the sky and set in the western part of it. The Pole Star does not seem to move. The shooting stars look like flashes. They are visible just for a few moments. The man-made satellites can be seen moving in **various** directions.

If you observe carefully, you will see that the sun and the moon move quite rapidly. The time interval between one sunrise and the next in our country is nearly 24 hours, and the time interval between one moonrise and the next is nearly 25 hours. You will generally find that if you observe a heavenly body at some place in the sky, it will be visible at about the same place after 24 hours.

(c) Many stars are seen in groups or **clusters**. For example, the cluster called the **Great Bear** (*Saptarishi*) is a

formation of seven stars. All the seven stars in this cluster move **together** in the sky. Therefore, the pattern of the cluster does not change during their movement. You can identify several such clusters, called **constellations**, in the sky. Some other well-known clusters are: *Ashwini, Bharani, Chitra* and *Mriga*.

Planets appear to move from one **cluster to another**. The planet **Jupiter** may be seen at one time near *Ashwini*. Three months later, it may be found near *Bharani*.

We can easily distinguish a star from a planet. A planet is generally brighter than most stars and does not twinkle. A star twinkles.

The moon is probably the most attractive object in the sky. The moon exhibits **phases**. On the day just after the new-moon day, a bright crescent of the moon is visible in the western sky immediately after sunset. On the full-moon day, the entire disc of the moon is visible on the eastern horizon at sunset. On the new-moon day we do not see the moon at all.

Those of you who have seen the sea would have noticed the tides. Sometimes, the waters of the sea are quite high, and huge breakers are seen near the shore (**high tide**). About six hours later the water seems to be drawn in and the sea appears quiet (**low tide**). After about another six hours we see the high tide again.

If you observe carefully, you will notice that the moon is often nearly overhead when the tide is high. Are the tides related to the moon?

Have you seen an eclipse? Sometimes, a part of the sun becomes invisible for a short time (a **partial solar eclipse**); on a few occasions, the **entire** sun can become invisible (a **total solar eclipse**). A solar eclipse occurs only on a new-moon day.

Sometimes, the moon becomes partly or fully invisible for a short time (a partial or a total **lunar eclipse**). A lunar eclipse occurs only on a full-moon day.

2. QUESTIONS

2.1 How big is the sky? Does it have a boundary or is it limitless?

2.2 Staying on earth, how do we manage to learn so much about heavenly objects?

2.3 What are the heavenly objects made of ?

2.4 Do the heavenly objects affect the earth? If so, in what way ?

2.5 What are the similarities and dif-

ferences between various heavenly objects?

2.6 What are shooting stars and comets?

2.7 Why do stars twinkle and planets do not?

2.8 Is there life anywhere else?

2.9 Man has now been to the moon. How does it look out there?

2.10 Why does moon show phases? Where is the moon on the new moon day when we cannot see it at all ?

2.11 How are eclipses caused? And why only on particular days related to the phases of the moon?

2.12 What does the solar system, that is, the system of our sun and the planets, look like?

2.13 Why do heavenly objects rise and set? Why do they move at all?

3. LET US FIND OUT

3.1 The earth

What do we know about the earth?

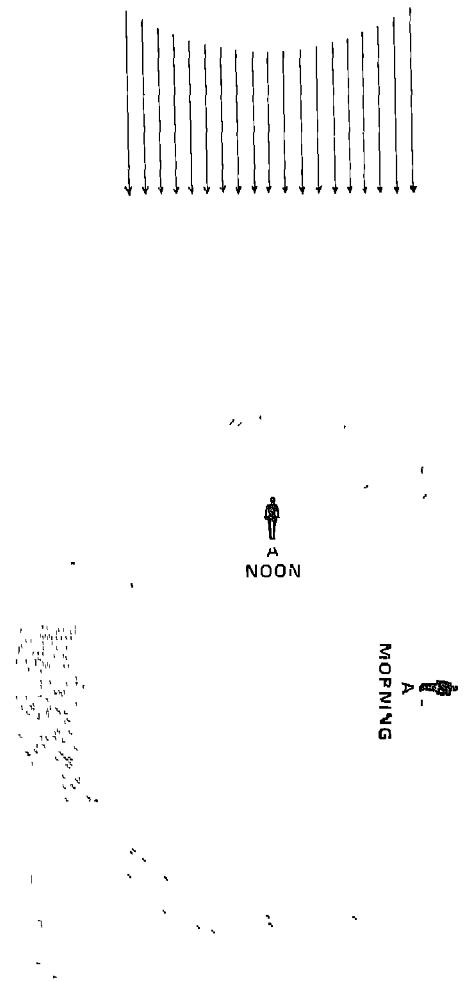
You have already learnt that the earth is a **spherical** object. We now have a direct proof of the earth being round. Astronauts have taken photographs of the earth from space. These photographs show the earth to be a round spherical object.

The earth is a **large** object. It has a diameter of 12,800 km or a radius of 6,400 km. Let us suppose that we wish to make a model of the earth in brass. If we choose a scale of 1000 km = 1 cm, we can represent the earth by a brass ball with a radius of 6.4 cm. Let us try to show some important features of the earth, like its famous mountains and rivers, on this model. The tallest mountains, the Himalayas, are on the average 7000 m high. (Mount Everest, the tallest peak in the Himalayas, has a height of 8840 m).

On the brass model, these mountains will have a height of 7/1000 cm, that is, 7/100 mm. If the brass ball has such heights made on it, you would not be able to see them: you may just be able to feel them with your fingers. Features like rivers and cities will neither be seen nor felt. You will now realise why scale drawings are difficult to make when you are describing big bodies like the earth, the sun or the moon.

The earth is surrounded by air. The layer of air surrounding the earth is called the earth's **atmosphere**. Earth has an atmosphere which extends up to 300 km. Air is densest at the sea level As we go up, the air becomes thinner The atmosphere above, say, 30 km is so thin that there is not

enough air to breathe. Plants do not grow at heights greater than 6,000 m



PICTURE 1

The above picture (**P** 1) shows that at the place A, the rays of the sun travel through different thicknesses of the earth's atmosphere at noon and at sunrise. At noon, the total thickness of the atmosphere through which the rays have to travel is nearly 300 km, while at sunrise the rays go through nearly 650,00 km of the atmosphere. That is why it is hotter at noon time than at sunrise.

The sun emits several kinds of rays: X-rays, ultra-violet rays, heat rays and white light rays When they go through our atmosphere, many things happen X-rays and ultra-violet rays, which can cause immense harm to living forms on earth, are mostly filtered by the top layer of the atmosphere. The heat and light rays come through. These rays are **scattered** (that is, bounced off in all directions) when they hit the molecules in the air. Can you now see why there is light everywhere when the sun rises? At sunrise it is daylight all over your village or town and — if you keep the windows open — you can see things in your house even if the sun's rays do not enter directly into the house. Can you now guess why we cannot see the stars during the day?

The white rays of the sun actually consist of violet rays, indigo rays, blue rays, green rays, yellow rays, orange rays and red rays. These rays are scattered by the molecules in the air to different extents. The blue rays are scattered the most of all. Can you now say why the sky appears blue?

3.2 The motion of objects in the sky

Most heavenly objects appear to be moving. The sun, the moon, most

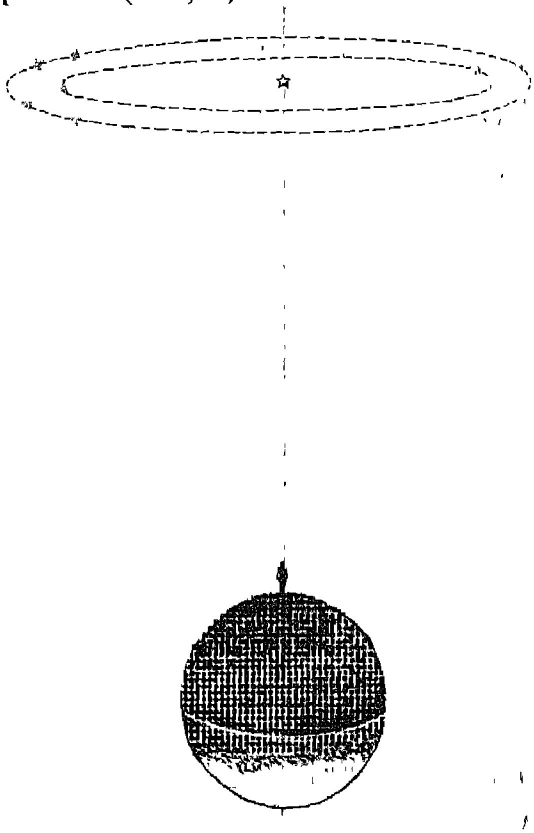
stars and all the planets appear to rise somewhere in the east and set in the west. It appears, therefore, that they are all going round the earth. We should, therefore, not be surprised that man in ancient times thought the earth to be at the centre of the universe and every object in the sky to move round the earth.

Careful observation soon showed that things are not all that simple. Let us now go through some of these observations.

(**a**) We find that the pole-star is practically stationary. All heavenly objects, therefore, do not go round the earth.

(**b**) Imagine someone living in the northern parts of the earth — say, in Canada or Sweden — as close to the north pole as possible. He will find the pole-star almost overhead in the night sky and the stars near about the pole-star moving **around the pole-star.** The stars further away from the pole-star would also seem to go round the pole-star, but a part of their circular path would not be seen as it would be hidden by the body of the earth. If we stand **exactly** at the north pole, we will see all the stars in the sky completing one circle around the pole-star in 24 hours!

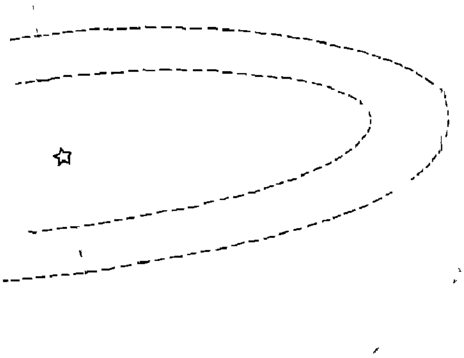
Then why do we, living in India, see the stars moving from east to west, around the earth? This is because we are near the equator, far away from the north pole. The pole-star is not overhead for us. Nearly half of the circular path of the stars around the pole-star is hidden by the body of the earth. This should be clear to you from pictures (**P**2a, b).

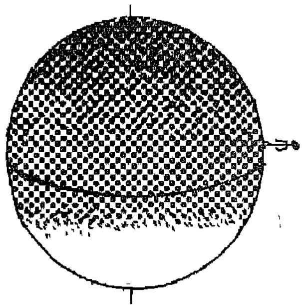


PICTURE 2a

The above observations now raise a doubt. Do the stars move around the earth, or around the pole-star or around some other object? Why should they move around anything at all?

Let us look more closely.





PICTURE 2b

(c) We see some stars in clusters. If we observe those clusters regularly, we can easily learn to identify them. As we have already seen, all the stars in the cluster move **together** so that the entire cluster seems to move as one in the sky (**P**2b).

(d) We often see in the sky some star-like objects which move from east to west **through** the clusters. Suppose we observe three clusters, A, B and C; A is towards east, B is in the middle, and C is towards the west. If we observe carefully, we can see an object which is close to A today, moves towards B in, say, a month's time, and towards C in another month. On any one day, of course, it will rise and set with the same cluster.

We now know that such objects that move through clusters are called **planets**. Man, in ancient times, learnt to tell the planets from the stars on the basis of the observation described above

(e) All these puzzles were solved rather easily when it was realized that the earth is spinning around itself with its axis passing through the north and south poles. The stars and planets do not move round the earth; it is just that different portions of the sky come in view as the earth spins round its axis — just as it happens in a merry-go-round! Since the earth takes nearly 24 hours to complete one rotation around its axis, the sky also seems to take 24 hours to move around us. Can you now guess why the pole-star does not appear to move? Here is a clue to the answer. Stand in a room directly under the ceiling fan. Now start spinning around yourself. Which objects in the room do you see moving when you are doing this? Is there any object that does not appear to move? Yes, the ceil-

ing fan — because it is exactly in line with you. The pole-star is very nearly in line with the axis of the earth

The earth has two more motions. It moves around the sun in a nearly circular path, completing one round in nearly 365 days. All the other planets too go round the sun in different paths. In fact, the sun with its planets is one system, called the **solar system.** The entire solar system is also moving, carrying the earth with it.

All this knowledge has been presented to you in only a few pages here, and you will learn it in a few lessons Remember that it has taken man hundreds of years to discover these interesting facts. The ability to acquire new knowledge and to pass it on to the next generation is a very special quality of man.

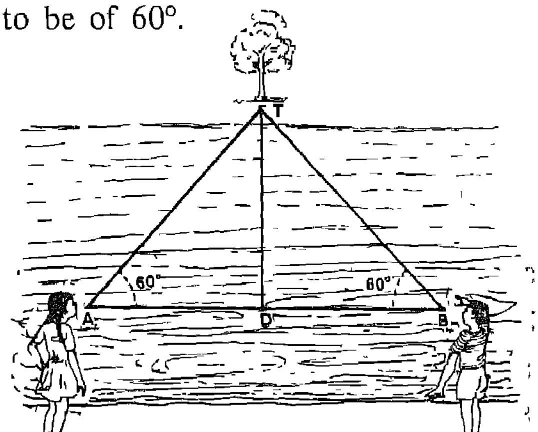
3.3 The distances

How big is the sky? How far are the heavenly objects from us? We have learnt to measure lengths. Can we measure the distance from the earth to the moon? The obvious difficulty is that, for all practical purposes, we are confined to earth! Can we measure distances in the sky without leaving the earth?

Let us try a simple experiment. In the picture (**P**3) given here, you see two children on the bank of a big river. They want to know how wide the river is but, unfortunately, they cannot swim. What should they do?

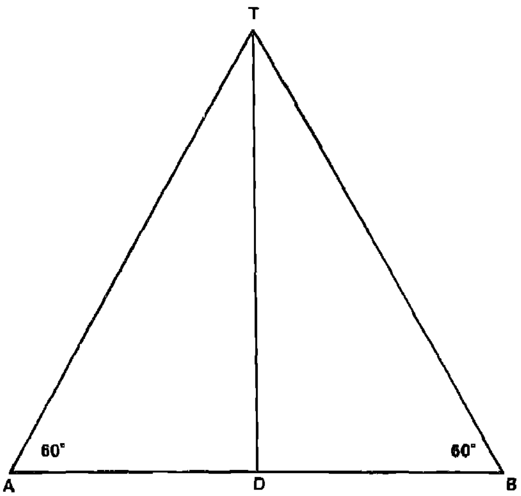
One of them has a bright idea He notices a tree on the opposite bank of the river. Using the protractor in his compass box and a pencil, he makes a device for measuring angles.

Holding the protractor so that AB is parallel to the river (that is, in the same direction as the length of the river), he measures the angle between AB and AT indicated by the dotted line in the picture He then moves 200 metres down the river bank and measures the angle between AB and BT. Let us say, he finds both the angles to be of 60°.



PICTURE 3

Then he makes a scale drawing (**P**4). Using the scale 20 m = 1 cm, he draws the line AB as equal to 10 cm. At A and B, he draws lines making an angle of 60° with AB. The lines cross at T. He then draws the line TD (perpendicular to AB) which can be measured in centimetres. Using the



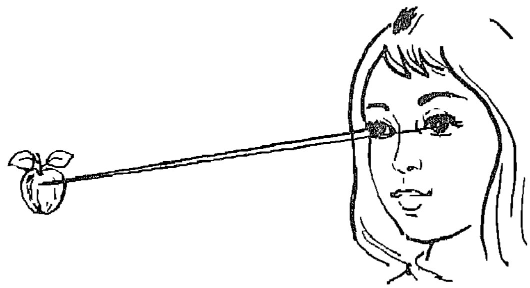
PICTURE 4

scale 1 cm = 20 m, can he now find out the width of the river?

Try this method to measure the height of a tree, or the width of a field, or the depth of a quarry.

The method described above is known as the **method of triangles**. It is possible to use this method to measure relatively large distances. For example, if we observe the moon from two different places on the earth at the same time, and note the angles, we can estimate the distance separating the earth and the moon.

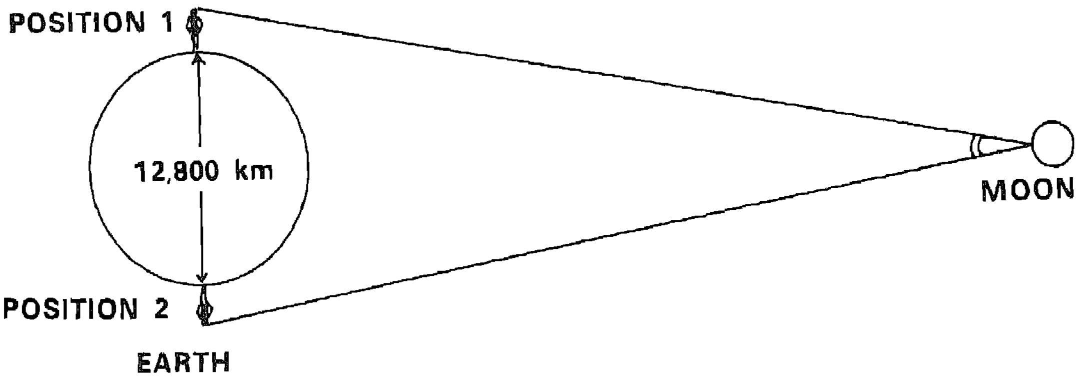
The moon, however, is so far away from us that even if the two places chosen to measure the angles are situated 1,600 km apart, the angle at the moon would be only one fourth of a degree! In picture **P**5, two eyes represent the two points on the earth and the apple represents the moon Hence, to measure large distances, one



PICTURE 5

has to use instruments capable of measuring angles correctly up to a small fraction of a degree. In the experiment on measuring the width of the river, if the clever boy had been lazy and had walked only 1 m from position A (instead of 200 m), he would have been forced to use very accurate instruments. Otherwise, he would not have been able to measure the width.

On the earth, we cannot find two places that are separated by more than 12,800 km (can you guess why?). What, then, can we do if the object is so far away from the earth that even when two points on the earth are 12,800 km apart we cannot get a measurable angle? There is, in fact, something that we **can** do. We know that the earth moves round the sun in a nearly circular path. We can use the two extreme positions 1 and 2 shown in the picture (**P**6), the distance between which is very much greater than



PICTURE 6

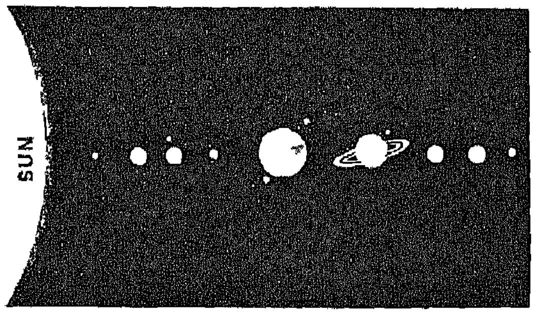
12,800 km. When even such large distances are not enough, there are other methods to measure distances of heavenly bodies from earth. We shall learn about these methods in later classes.

Using such methods, the distances between the sun and the planets have been measured. They are listed in Table 1. (This table is only for your information. You do not have to memorise it.)

Table 1 will show you that the solar system is **very big**. As you go away from the sun, the distance between one planet and the next increases. You may find it of interest to note that the distance between **Jupiter** and **Saturn** is nearly the same as the distance between the sun and **Jupiter**. Similarly, the distance between **Saturn** and **Uranus** is almost the same as the distance between the sun and **Saturn**.

We will appreciate the vastness of the solar system better if we try to make a model. Let us represent the sun by a balloon one metre in diameter. Where should we place the planets, and what would they look like? Table 2 and picture **P**7 will give you an idea.

On this scale the star nearest to us other than the sun would be 7,230 kilometres away. If you kept this model in a small town near Delhi, with the sun at the centre of the town, **Neptune** and **Pluto** would be on the outskirts of the town. The nearest star would be somewhere near New York (USA)!



PICTURE 7

Courtesy. *Homi Bhabha Centre for Education, Bombay.*

TABLE 1

THE SOLAR SYSTEM

Name	*Radius (in thousand kilometres)*	*Distance from the sun (in million kilometres)*	*Time taken for one rotation around its axis*	*Time taken to go round the sun once*
Sun	691.5	—	25 days	—
Mercury	2.4	57 6	59 days	88 days
Venus	6.1	107.5	243 days	225 days
Earth	6 3	148.7	24 hr	1 year
Mars	3.4	226.6	24 hr, 37 min	1.9 years
Jupiter	71.4	774.7	9 hr, 54 min	12 years
Saturn	60.0	1416	10 hr, 14 min	29.5 years
Uranus	23 4	2866	10 hr, 49 min	84 years
Neptune	22 3	4493	15 hr	165 years
Pluto	1.8	5904	6.4 days	248 years

TABLE 2

DISTANCES, IF WE CONSIDER THE SUN AS A BALLOON WITH A DIAMETER OF ONE METRE

Name	*Diameter (in mm)*	*Distance from the balloon (in metres)*	*Will approximately look like*
Mercury	3.5	41 6	A large pea
Venus	8.5	78	A large grape
Earth	9	107	A large grape
Moon	2.2	107 (Approx)	A small pea kept at a distance of 30 cm from the earth

Mars	4.5	164	A small grape
Jupiter	100	560	A ball slightly bigger than a cricket ball
Saturn	87	1024	A ball slightly bigger than a cricket ball
Uranus	34	2072	A lemon
Neptune	32	3248	A lemon
Pluto	4	4268	A very large pea

The planets are rather close to us. Hence the planets appear as small discs when seen through a powerful binocular or a simple telescope. The stars are so far away that they appear only as points even through a telescope. Due to air currents and other disturbances in the atmosphere, the point image of the star vibrates a little so that the star seems to change its position very slightly. This is what makes stars twinkle. The planets are close to us and appear as discs. Planets do not twinkle as their disc images do not vibrate much. If you go to the moon where there is no atmosphere, and look at the sky from there, you will not see the stars twinkling.

Several million stars like our sun form one galaxy, and several such galaxies have been seen, identified and named. You may now appreciate how big the universe must be. Even today, we do not know whether the universe has a boundary or no boundary at all.

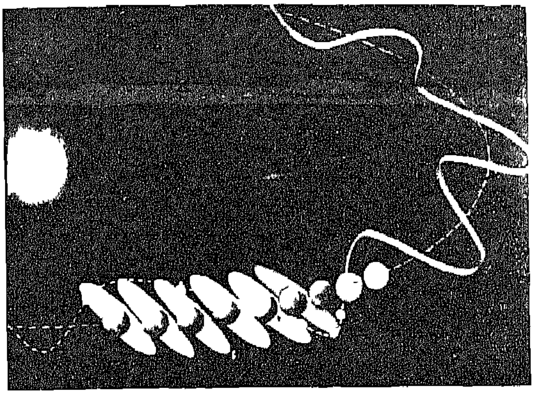
3.4 The moon

Our nearest neighbour in the sky is the moon. Let us learn a few things about the moon and its behaviour.

The diameter of the moon is nearly 3,360 km. The distance between the moon and the earth is not constant; it varies slightly, but the average distance is 3,84,000 km. Using special light devices (called **lasers**), scientists have been successful in measuring the distance from the earth to the moon at any given time, correct to a centimetre.

Heavenly objects that revolve round the sun are called planets. The earth is a planet of the sun. Heavenly objects that revolve round a planet are called satellites. The moon is a **natural** satellite of the earth. **Aryabhata** is an **artificial** — that is, man-made — satellite of the earth.

The moon moves round the earth **as well as** round the sun along with the earth. The picture given here (**P**8) will show you the path of the moon

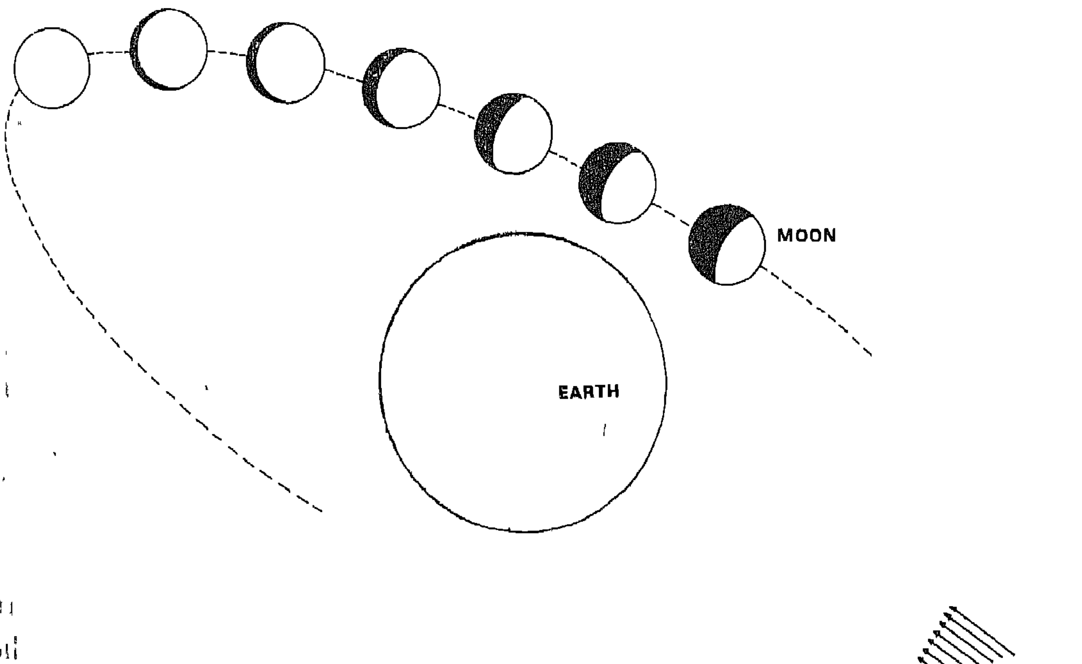


PICTURE 8

Courtesy *Homi Bhabha Centre for Education, Bombay.*

round the earth and the sun Notice that the moon moves round the sun in a zigzag path.

You have observed that the moon shows phases. Why does the moon show phases? Remember that planets and satellites, like moon, do not emit light of their own. Only stars, like the sun, emit light. They do so because they are very very hot and all bodies which are that hot must emit light. The planets and satellites are seen when the light of the sun falling on them is reflected back to us. We, therefore, see the moon only when sunlight falls on it and is reflected back to the earth. We can see only that part of the moon which is lighted up by the sun and is towards us. Can you now see how the phases of the moon occur (P9)?



PICTURE 9

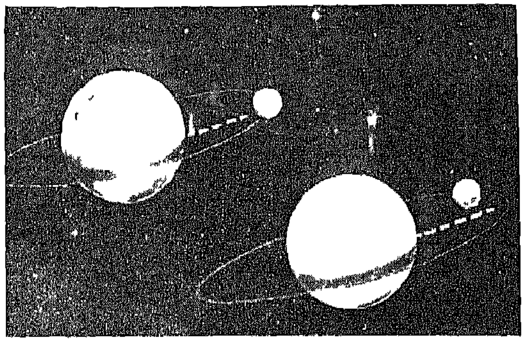
Immediately following the new-moon day, you will observe a crescent of the moon on the western horizon, just after sunset. The crescent is illuminated by sunlight. The rest of the moon is also faintly visible. Why? It is visible because it is illuminated by light **reflected from the earth**, that is, by **earthlight** instead of **sunlight**! The sunlit part of the moon is, of course, much brighter than the earthlit part, as direct sunlight on the moon is much stronger than the sunlight reflected from the earth.

The earthlight on the moon is, however, stronger than the moonlight falling on the earth. You can read a book on the moon in earthlight. You cannot read a book on the earth in moonlight.

The moon moves round the earth in $29\frac{1}{2}$ days. The earth spins around its axis in 24 hours By the time the earth has completed one rotation, the moon has moved ahead in its path round the earth (**P**10). That is why the time between one moonrise and the next is 24 hr 50 min.

$$\frac{24 \text{ hr}}{29.5 \text{ days}} = 50 \text{ min per day}$$

On a full-moon day, the moon rises about the time the sun sets. On this day, the sun and the moon are on the opposite sides of the earth. As the



PICTURE 10
Courtesy: *Homi Bhabha Centre for Education, Bombay.*

moon rises 50 minutes later every day, after about 15 days the moon would rise approximately with the sun. When the sun rises, the entire sky is so bright that we cannot see any other object in the sky. This day is the new-moon day.

From now on, the moon rises after the sun (so that we cannot see the moonrise), and sets after the sun sets. That is why we now see the moon on the western horizon after sunset. Eventually, the moon rises approximately at sunset and we have the full-moon day again.

3.5 The calendar

The phases of the moon give us a calendar. From one new-moon day to the next — that is, for one revolution of the moon round the earth — it takes $29\frac{1}{2}$ days (one 'lunar' month). Since 12 months make a year, a **lunar year** has 354 days.

The earth takes 365.25 days to go round the sun once. The **solar year** is taken to be 365 days. And to account for the remaining 0.25 day, one day is added to the solar year every 4 years (the leap year).

We now have two different calendars, one lunar and the other solar. If we do not do something to make them agree, *Diwali* will occur 11 days earlier every solar year. In a few years time, you will have to celebrate *Diwali* in summer! In order to avoid such difficulties, the ancient Indian lunar calendar added an extra month every three years. Now, of course, we have realised that the solar calendar is more convenient, and have decided to use it in our country for all official work.

The *Hijri* calendar is also based on the lunar year, but the above addition of an extra month is not made. That is why you find that *Id* is not celebrated in the same solar month every year.

3.6 The eclipses

Whenever light falls on a body, the body will cast a shadow. We see shadows being cast on the ground every day. Similarly, the earth, the moon and the planets also cast their shadows in space. However, we cannot see these shadows **unless they fall on some object**. The shadows of birds flying at a great height cannot be seen on earth but we can easily see their shadows when they fly nearer to the ground. (Can you name some of the objects of which we see the shadows in daily life?) Sometimes, on a full-moon day, the moon passes through the shadow of the earth. When this happens, we cannot see the moon's disc until the moon comes out of the shadow. A lunar eclipse occurs in this way.

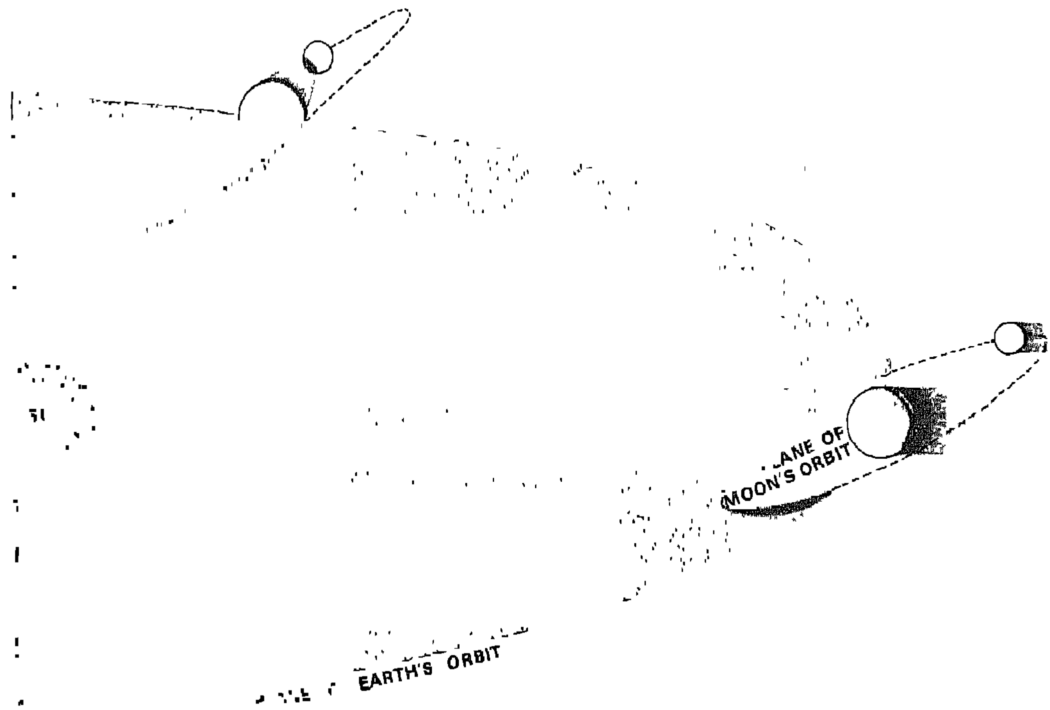
If the entire disc of the moon passes through the shadow, we observe a total lunar eclipse. If only a part is covered by the shadow, we call it a partial lunar eclipse. The width of the earth's shadow at a distance of 400,000 km is nearly 3 times the moon's diameter. You will, therefore, never observe an **annular** lunar eclipse (that is, an eclipse in which only the central part of the moon's disc is covered with the shadow, leaving a bright rim visible).

On the new-moon day, if the sun, the moon and the earth are in a straight line, the shadow of the moon can fall on the earth. If we are in this shadow, we will not be able to see that part of the solar disc which is covered by the moon. This is what happens in a solar eclipse.

The moon is small but near enough. The sun is very big but far

away. It is entirely by chance that the sun and the moon appear to have approximately the same size when viewed from the earth. This would make a total or annular eclipse of sun by the moon difficult. However, the path of the moon round the earth, and that of the earth round the sun are not perfect circles. The apparent sizes of the lunar and solar discs, therefore, change slightly. Hence, occasionally it is possible for a solar eclipse to be total or annular. Partial solar eclipses are, of course, much more common.

You might wonder why an eclipse does not occur every full-moon day or every new-moon day. The plane in which the moon moves round the earth and the plane in which the earth moves round the sun are not the same. They are slightly tilted with respect to each other as shown in picture **P11**. As a rule, therefore, the shadow of the moon misses the earth on the new-moon day, and the shadow of the earth misses the moon on a full-moon day.



PICTURE 11

If, however, the full-moon day or the new-moon day occurs when the moon is at the point where the two planes cross, then the sun, the moon and the earth are in a straight line, and eclipses occur.

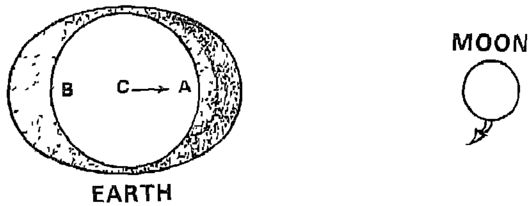
The eclipses are simply a play of shadow. Knowing the movements of

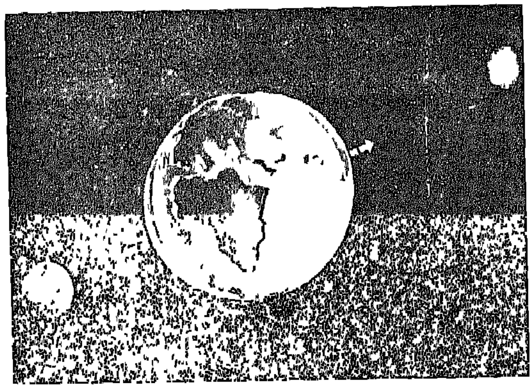
the sun, the earth and the moon, we can **predict** the eclipses, that is, tell you when they will occur. These predictions are very accurate.

You can watch a lunar eclipse with the naked eye. Direct rays of the sun are, however, very strong. **You must never watch the sun without protecting your eyes.** If you wish to see a solar eclipse, take a piece of plane glass (not curved; that can be dangerous) and blacken it with soot. It should be so black that, except the sun, nothing should be visible through it. Use this piece of glass to look at the sun. Alternatively, take a piece of cardboard with a pinhole at the centre. Using this cardboard, you can obtain an image of the sun on the wall. You can look at the image on the wall safely. But do not ever look at the sun directly!

3.7 The tides

There is one more effect caused by the moon. The earth and the moon pull each other due to gravity. As we already know, the gravitational pull decreases rapidly as the distance increases. The pull of the moon at point **A** on the earth in the above picture (**P**12) would be stronger than the pull at the centre **C**. The pull at point **B** would be the weakest. This





PICTURE 12

Courtesy *Homi Bhabha Centre for Education, Bombay.*

difference in the strength of pulling results in a bulge at **A** and **B**. A bulge occurs at **B** because this point is not pulled as strongly as the centre **C** and, therefore, lags behind. In other words, the difference in the pull of the moon at places towards and away from the moon causes bulges on the earth. When these bulges occur on the sea, we have tides.

The tides can be seen more easily on the sea shore. The water rises when **A** is close to the moon (high tide), and goes back when **A** gets further away from the moon (low tide). Actually, the land is also pulled. The land, however, is rigid and does not yield so much. In fact, it is the difference between the

extents to which water and land on earth yield under the pull of moon's gravity that makes it possible for us to see the tides.

Can you now see why the high tide occurs approximately every 12 hours and not after every 24 hours? Remember, there are **two** bulges.

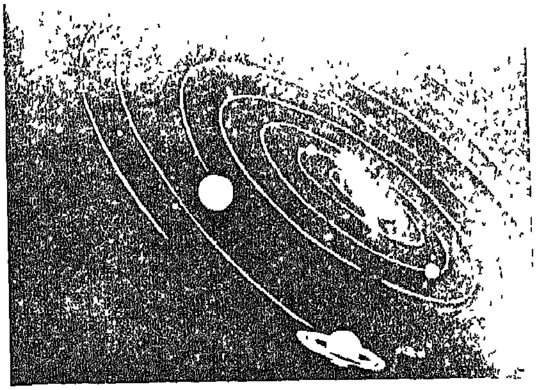
The sun also pulls the earth. In fact the pull of the sun is stronger than that of the moon. However, the sun is so far away that the **difference** of the sun's pull at **A**, **B** and **C** is very small. Hence solar tides are nearly half as small as the tides due to the moon.

On the full-moon day and on the new-moon day, the tides caused by the sun and the moon occur at the same time. On these days, therefore, we observe the highest tides.

3.8 The solar system is a *'Jalebi'*!

The solar system consists of the sun and the planets. The planets move round the sun. The paths of all the planets lie in approximately the same plane. The solar system, therefore, is flat like a *jalebi* (**P**13).

You can make use of the above fact in identifying planets. If you see **Jupiter** in the east and, say, **Venus** in the west and you wish to locate, say, **Saturn** or **Mars**, look for it in a line joining the two planets you have already identified (**P**14).



PICTURE 13
Courtesy: *Homi Bhabha Centre for Education, Bombay*

PICTURE 14

All the planets move round the sun in the **same** direction.

3.9 The comets and the shooting stars

Sometimes, you see a comet in the east just before sunrise or in the west just after sunset. The comets are small — as small as the moon or **Mercury** — but they have a lot of dust around them. Since they have no light of their own, you cannot normally see them. When they come close to the sun, they are so strongly illuminated by the sun that they become visible. When a comet is close to the sun, the effect of the sun on the comet is so strong that light and other particles emitted by the sun push the dust of the comet away. It is the dust pushed in this way that makes the tail of a comet! That is why you will always see the tail of a comet directed away from the sun. Some comets go round the sun regularly, and their appearance can be predicted. Some comets visit the solar system once and then move out into space, probably never to return again.

We have already seen in Chapter 5 that shooting stars are not stars! They are rock-like objects that have strayed into the earth's atmosphere.

3.10 What are they made of?

Most heavenly bodies are spherical, and all heavenly bodies are made of the same 100 and odd elements that we know on the earth. Man has now gone to the moon and brought back some lunar rocks and soil. These materials have been found to be similar to those found on the earth.

The stars differ from each other in size and brightness. There are some stars that are as big as half the solar system and they are red in colour. Some stars are as small as **Jupiter** or even earth, and they emit a bright blue or white light.

3.11 Is anybody there?

You must be wondering whether there is life anywhere else. As yet no one knows the answer to this question. When you study living objects in the next chapter, you will understand the conditions necessary for life to exist. If these conditions are available anywhere else in the universe, there is a good **chance** that life may exist there. Scientists are at present looking for very simple forms of life — such as bacteria — on certain planets, such as **Mars**. They already know that more complex forms of life do not exist on the planets of our solar system.

Man has been 'up' there on at least one heavenly object: the moon. He found no life there, no water and no air. When the sun shines on the moon, the temperature can be as high as 130°C; when the sun sets there, the

temperature falls much below the temperature of ice. Life is unlikely to survive in such extreme conditions unless protected by modern technology.

Spaceships carrying instruments have been sent to Mars and Venus. Recently, a space vehicle called Viking landed on Mars. The Viking has equipment capable of searching for life. So far, no evidence of life has been found on Mars, but the search continues.

4. ACTIVITIES

4.1 Prepare a scale model of the solar system. You can use spheres of clay to represent planets. Using the numbers given in Table 1 or Table 2, prepare spheres of appropriate diameters to represent the sun and the different planets, and insert a pin in each sphere before the clay dries up. You may find it convenient to make the sun about 10 cm in diameter. Paint the sun white and the other planets with other different colours.

Now arrange the sun and the planets in a line, according to their distance from each other, using the information given in Table 1 or Table 2. How many planets can you accommodate in your model without going out of your school ground?

4.2 Try to identify as many planets as you can. An easy way to identify Venus is to look into the western sky just after sunset, or into the eastern sky just before sunrise. Venus is the brightest object in the sky apart from the sun and the moon. Jupiter looks yellowish and Mars reddish.

4.3 Note the time of sunrise and of sunset every Sunday for three months. Compare them with the times mentioned in the local almanac (*panchang*) or newspaper. You can say from your observations whether or not the length of the day has changed during this period. If so, in what manner did it change? For example, did the day become longer or shorter?

4.4 Find out the length of your school playground by the method of triangles. If a natural vertical object like a tree is not available, you can erect a pole at one end of the ground. Compare your results with the length of the ground measured with a measuring tape.

4.5 Observe and record the phases of the moon and the time of moonrise over a month (30 days).

4.6 Try to identify some constellations. You will find that you can easily identify constellations known as **Great Bear**, *Ursa Minor* and **Orion**. Observe

their position at a definite time every night. Do you find them in the same place everyday?

4.7 Find out how long does it take for the sun to set, from the time the bottom of the solar disc touches the horizon to the time the sun disappears completely.

4.8 Hang a pendulum from any support in the open sun. Let the shadow of the pendulum fall on a white sheet of paper. Quickly mark the shadow with a sharp pencil. Make sure that your pencil mark and the shadow coincide, that is, fall at the same spot. Now say **Tungabhadra** 10 times without looking at the shadow. As soon as you have said it the tenth time, turn back and look at the shadow. Do the pencil mark and the shadow still coincide? If not, why?

4.9 On a bright sunny day, take a metre stick and ask one of your friends to hold it vertically near a tall tree. Measure the lengths of the shadows cast by the metre stick and by the tree. Can you now calculate the length of the tree?

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 The objects in the sky

The heavenly objects we see with the naked eye may be broadly classified as stars, planets, satellites, meteors (that is, shooting stars) and comets. The sun is a star. Stars give out their own light. The planets rotate round a star such as our sun, and they get all their light and heat from the star. Our earth is a planet. We have learnt that **all** heavenly objects are made of the same elements that we find on earth.

The distances between the earth and the planets or some neighbouring stars can be estimated by using a simple method called the method of triangles. For distant stars, the method of triangles is not suitable and other methods have to be used to estimate their distances from the earth.

5.2 The earth, the moon and the sun

The earth completes its journey around the sun in 365.25 days. This interval of time is called a solar year. The earth also rotates about its axis once every 24 hours. This rotation of the earth causes day and night. Almost all the heavenly objects appear to rise in the east and set in the west because

of the rotation of the earth around its axis.

The earth is surrounded by an atmosphere, which prevents harmful radiations from the sun reaching the surface of the earth. The molecules present in the atmosphere also help in spreading the light of the sun to areas which do not receive the light directly. The blue colour of the sky is due to the fact that sunlight consists of light of several colours, of which the blue light is scattered the most by the earth's atmosphere. If the sun were to emit, say, only red light, the sky would not appear blue!

If we go out of the atmosphere of the earth, we will no longer find a blue sky over our head. Instead, the sky will appear completely dark. From the moon, the sky looks completely dark.

In the morning and in the evening, the rays of the sun have to travel a much larger thickness of the atmosphere compared to that at noon. That is why morning and evening are cooler than noon.

The moon is the nearest neighbour of the earth in the sky. It is a natural satellite of the earth. It revolves round the earth in about $29\frac{1}{2}$ days and also revolves round the sun along with the earth. The periodic motion of moon around the earth gives us a lunar calendar.

The moon appears bright because it reflects the light of the sun falling on its surface. The phases of the moon occur because of the particular manner in which the moon goes round the earth.

Our nearest neighbour, the moon, pulls the part of the earth towards it more strongly than the part away from it. This difference in the force of attraction gives rise to tides.

The sun is the only source of light (and heat) in the solar system. When sunlight falls on planets, they cast shadows in space which are normally not visible. However, the earth and the moon are so close to each other that it is possible for the moon to cast its shadow on the earth (solar eclipse) or for the moon to pass through the shadow of the earth (lunar eclipse). Remember that a solar or lunar eclipse can occur only when the sun, the earth and the moon are in a straight line.

5.3 The other heavenly bodies

There are nine known planets, including the earth, in the solar system. The planets go round the sun at different distances from the sun. We can see **Venus**, **Mars**, **Jupiter** and **Saturn** as bright objects in the sky due to the light of the sun they reflect. We can identify the small number of planets among the large number of

stars we see, by the features given below:

(i) The planets usually appear brighter than the stars.

(ii) The planets do not twinkle as the stars do.

(iii) Apart from their daily east-west motion, the planets appear to move **through** constellations as well. This motion is due to their movement around the sun. In the case of stars, the pattern of a constellation as seen from the earth, does not show observable changes.

We have also learnt that the solar system is flat like a *Jalebi* and that all the planets of the solar system move in approximately the same plane

Some comets are a part of the solar system. These comets are seen at regular intervals. Comets that are not a part of the solar system appear only once. The tail of the comet is always directed away from the sun.

We have also learnt that almost all the heavenly objects are spherical in shape So far, life has not been discovered on any other heavenly object.

We have learnt that solar system is only a small part of the universe. The universe is very, very vast, and the earth on which we live is a very, very tiny speck in the universe. In spite of the considerable knowledge we now have about the universe, we are still not able to answer the question: does the universe have a limit or is it unending?

CHAPTER 8

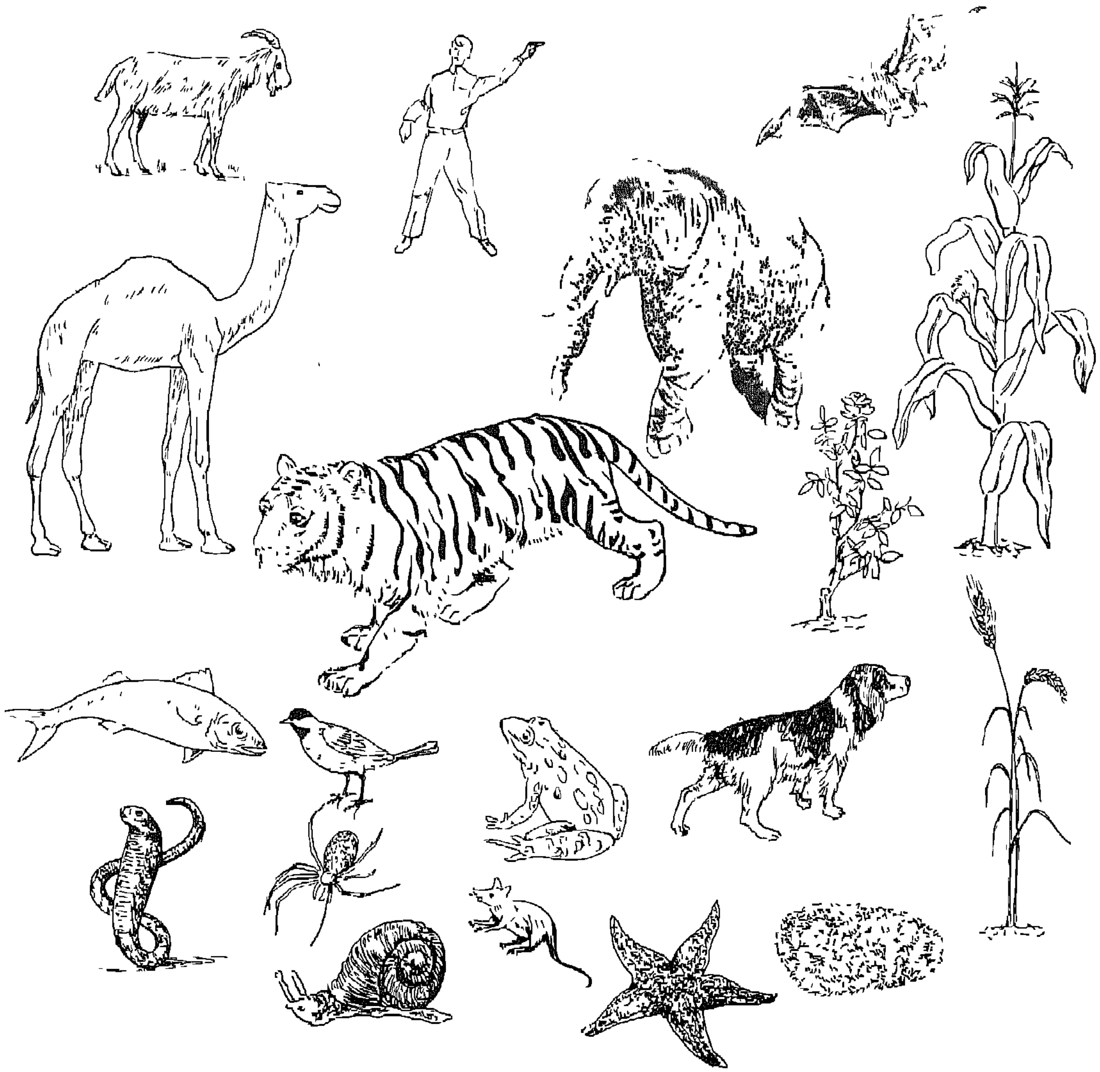
THE LIVING WORLD*

1. OBSERVATIONS

1.1 We observe a large variety of living objects, that is, living forms or organisms around us (**P**1). For example:

Man	Rose bush	Millipede	Pine
Rat	Jasmine creeper	Coconut	Gibbon
Mouse	Fowl	Frog	Chimpanzee
Housefly	Pea plant	Toad	Planaria
Spider	Gram plant	Camel	Hydra
Mosquito	Wheat plant	Woodpecker	Sponge
Wall lizard	Maize plant	Vulture	Jelly fish
Cat	Mango tree	Kite	Star fish
Dog	Banyan tree	Crab	Octopus
Cockroach	Water lily	Fox	Cuttle fish
Bedbug	Leech	Acacia	Ostrich
Horse	Prawn	Bat	Emu
Donkey	Water bug	Peacock	Sea anemone
Cow	Duck	Tiger	Malarial parasite
Goat	Swan	Lion	Tapeworm
Sheep	Crane	Elephant	Roundworm
Snake	Slug	Zebra	Liver fluke
Fish	Snail	Leopard	Teak tree
Sparrow	Water mussel	Flamingo	Rubber tree
Myna	Moss	Rhinoceros	Wild duck
Garden lizard	Fern	Bear	

* Many of the living objects mentioned in this chapter are illustrated in the section **Interesting Information** towards the end of the book.



PICTURE 1

You may have seen some of these living objects. You may have heard of some. There would, of course, be many living objects that you may have seen or read or heard about which are not listed here. Prepare another list of 10 such living objects.

Some living objects are familiar to us in our houses. Some we see in the field or in the forest, in a pond or in the sea. Some we generally see only in a zoo or in special gardens. Can you classify the living objects you now know in the various groups mentioned above?

Some living objects are of use to us; for some, we have no specific use Many living objects, even though of

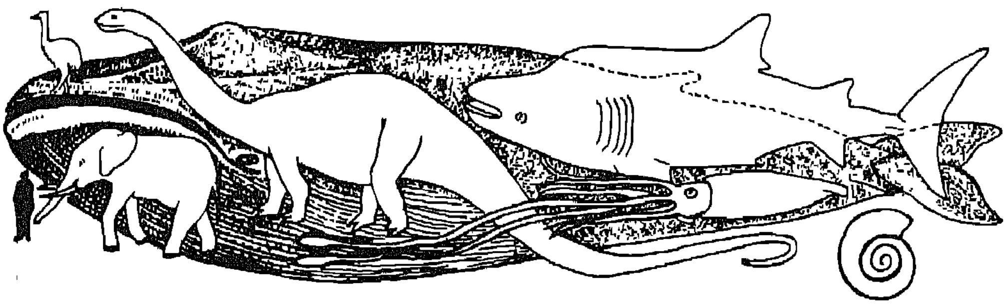
use, do not cause any obvious harm to man. Some, however, can be very harmful. Can you list some objects in each of these three groups?

Some living objects are very large. For example, redwood trees (found in North America) can be more than 90 metres tall. Blue whales are 30 metres long. Giant squids (found off South America) and whale sharks are over 15 metres long (**P**2).

during the cooler part of the day. They are often used as live fish food.

Spirogyra: Dark green, fine, thread-like objects found floating on stagnant pools and slow-moving streams; they often form a green scum on the surface of water.

There are living objects that are even smaller than those mentioned above. You cannot see them at all, unless you use a microscope or when



PICTURE 2

Some other objects are so small that you can barely see them with your eyes. Here are some examples for your information. You are not expected to memorize their names.

Hydra: A small, fine, thread-like animal found in clear ponds and pools; one end of the hydra is usually attached to a solid surface, while the other end remains free; the free end has 5-7 fine tentacles; the mouth is at the centre of this free end.

Water-fleas: Fine, dot-like whitish creatures found moving with jerks near the edges of clear ponds, usually

lots of them are together. Here are some examples:

Malarial parasites: Very tiny animals which cause malaria in man and in other animals. The **Anopheles** mosquito is the carrier of this organism.

Paramaecium: Minute, slipper-shaped animals found in stagnant pools.

Yeast: Very minute organisms which can convert sugar to alcohol and carbon dioxide gas.

Lactobacillus acidophilus: Bacteria which help to form curd from milk.

Vibrio cholerae: Comma-shaped bacteria (a group of very small living organisms) which cause cholera in man. They enter into the body of man through water and milk.

Salmonella typhi: Another type of disease-causing bacteria that cause typhoid fever in man.

Some living organisms live on land, some live in fresh water, some in the sea and some in the air. Out of those which live on land, some live on the ground, some inside burrows and some on the trees. Some living organisms can even live inside **other** living organisms. A very large number of living organisms (for example, many plants and some sea anemone) have a part of their 'body' within the ground and a part outside. Some living things can live both in water and on land. Can you give examples of each of the groups mentioned above?

Some living organisms can fly, while others cannot. Some can walk, swim as well as fly. Can you add other groups to this classification and give examples?

Some living objects — like most of the plants — are green; others come in a variety of colours. Can you list living objects which have a colour other than green, and classify them colour-wise?

Some living objects (like plants) are fixed to the ground; others are free to move. The type of movement can vary widely. Snakes crawl. Frogs jump. A cow can walk or run. Birds fly.

Some living objects can climb. Examples are: monkeys, squirrels, the money plant and the cucumber plant. Many living objects, such as an elephant or a camel, cannot climb.

The food habits of various living objects also vary a lot. Most plants can obtain all their food directly from air, water and soil. Other living objects are more 'fussy' in their food habits. Some (such as, deer, goat and cow) live on only plant material, while others (such as lion, tiger and snakes) can eat only meat. The female mosquito and the leech live on blood that they suck from other animals. Many living objects use a variety of other **small** living objects as food. The woodpecker lives on insects which it digs out from holes in trees. Toads and frogs live on insects and earthworms. There are some plants (such as *Drosera* and *Utricularia*) which also feed on insects.

Some living objects (such as man, weaver bird, ants, bees and termites) can build their own houses. Some, like snakes, are 'lazy' and live in houses built by others. Some (like lions and tigers) seek natural shelters; they live in caves or bushes. Some living objects live unprotected on open land (most of the plants), in open water (many algae

and fish), or in open air (many bacteria).

Some living objects, like the polar bear, the walrus, the reindeer, and the penguin, prefer cold climates and are found only in cold regions. Some can live in hot deserts; examples are: the camel, the cactus and the desert mouse. Some animals are confined only to certain countries or regions. For example, the platypus, the kangaroo and the emu are found only in Australia; the kiwi only in New Zealand; the ostrich, the giraffe and the zebra only in Africa; the llama, the macaw and the jaguar only in South America; the beaver only in North America; and the parakeet and the peacock mostly in India and the nearby countries. If you want to see an ostrich or a kangaroo in India, you will have to go to a zoo. The zoo gets them from the country they are found in and takes proper care of them. Some animals are found almost everywhere in the world; examples are: cockroaches, rats, mice, cows, sheep and dogs.

What we have said above is also true of many plants. For example, giant cacti are found only in Central American deserts. Eucalyptus tree, originally a native of Australia, has now spread all over the world. Similarly, potato and rose are now found everywhere. In fact, potato was brought to India from Europe only a century or two ago. And it was Queen Noor Jehan who introduced the rose in India about 350 years ago!

Some animals live at the same place all through the year; others migrate from their home during some seasons to a place which may be thousands of kilometres away. For example, the Siberian crane travels all the way from the Soviet Union **every year** to spend the winter in India at the Bharatpur bird sanctuary!

Some living objects live for very long. For example, the redwood tree can live for over a thousand years. A tortoise lives for nearly 150 years, and an elephant for a hundred years. Some others live for a very short time. For example, mayfly lives only for 24 hours, a mosquito for a few days, and a mouse for just one or two years. Some plants live for one season only, while others can live for years. Can you give examples?

1.2 You would have noticed that there are large differences between living objects. In fact, the differences are many more than what we have listed. Perhaps, you can add to the differences we have mentioned above. To give some more examples, virtually all living objects differ in shape, size and appearance. You would have noticed that **no two human beings are completely alike**.

2. QUESTIONS

2.1 How many different types of living objects are there?

2.2 Are there any characteristics common to all living objects?

2.3 We have looked at so many different ways of classifying living objects. Which would be the best way?

2.4 Where has life come from, and how did we come to have so many different types of living objects?

3. LET US FIND OUT

3.1 Number of living forms

Man has so far been able to identify about a million (1,000,000) different kinds of living objects.

3.2 Common features of living objects

You will notice that **all** living objects, without exception, share the following features:

(**a**) Like all non-living objects, **all** living objects are made **only** of elements and compounds; they have weight and occupy space.

(**b**) All living objects need food to live. No living object can live without some kind of food.

(**c**) Living objects are capable of reproducing more **of their own kind**. They never reproduce living objects which are not of their kind. Human beings reproduce only human beings. Dogs give rise to dogs. Cats give rise to cats. You can never obtain a guava tree from a mango tree, or a wheat plant from paddy.

(**d**) **All** living objects convert the food they take in, into materials and energy needed by them. They **excrete** (that is, throw out) whatever is not needed by them. Moreover, all of them do this in very similar ways. For example, bacteria convert the oxygen of the air into carbon dioxide in very much the same way as we do.

(**e**) **All** living objects can grow. The limits to which they can grow are, of course, different for different organisms.

(**f**) **All** living objects live for only a definite period and undergo definite changes during this period. For example, a human child grows to be an adult, then stops growing, becomes old and finally dies. You would notice that the same is true of all living organisms around you. No organism is such that it cannot die.

(g) **All** living objects react to the environment. We hear, see, feel, smell and taste. All these sensations are our reactions to the environment. The plants do not see, hear, feel, smell or taste but they react to the environment in other ways. You know what would happen to a plant if you did not water it!

(**h**) All living objects consist of **cells**. The cells, in turn, consist of a large number of atoms and molecules. Even the smallest known cell contains millions of molecules. A cell is, thus, very much bigger than atoms or molecules: even then, most cells are so tiny that you cannot see them with the naked eye. You need a microscope to see them.

The cell can be called a 'unit' of life. The number of cells a living object is made of varies enormously. Even a **small** organism like an ant is made of thousands of cells. On the other hand, bacteria (like *Vibrio cholarae*) consist of only one cell.

3.3 Classification of organisms

We have grouped several organisms in many different ways above. What would be the best way to classify them? You would agree that a good method of classification of objects should be such that

(**a**) The number of groups in which the objects are classified is small.

(**b**) The similarities between the members of each group are as large as possible.

Keeping these points in view, scientists have classified all organisms into a small number of groups. At the end of this book, you will find a section called **"Interesting information"**. In this section, in Set 1, you will find more details of these groups.

We often talk about plants and animals separately. Are there differences between plants and animals? Yes, there are some general differences.

Most plants can make their food from the water in the soil, carbon dioxide in the air, and sunlight. This process of preparation of food by plants is called **photosynthesis**. Animals cannot make their food in this way, but they can move from one place to another. Most plants cannot do so, because they are attached to the ground.

Scientists have realized that these differences between plants and animals are only **generally** true. There are exceptions to these rules. Many fungi cannot carry out photosynthesis; yet they are grouped under plants. On the other hand, sponges — which are

animals — are attached to surfaces and do not move.

We have earlier seen the wide differences between living objects Interesting similarities also exist between them. All human beings, for example, have some common features which enable us to recognize them as human beings. Similarly, the monkeys, apes and man have many similarities (can you name some?) Dogs, cats, tigers, lions, cattle and deer, all have four legs, hair on their body, ears outside the body, a tail and so on. All of them feed their young ones with their own milk. All birds have feathers and beaks, and do not have teeth. Turtles, lizards and crocodiles have dry scales and fingers with claws. All toads and frogs have smooth skin and fingers without claws. All fishes have four or five **gill slits** (through which they breathe) and paired fins with fin rays. And **all of the above animals** have one feature in common — the backbone !

3.4 The origin of life

Every event that occurs leaves a mark on its surroundings, just as you leave footprints when you walk, or finger-prints when you touch an object. One of the most interesting things that scientists do is to look for such marks or 'footprints' of the events that had occurred in the past. From these marks or 'footprints', they try to find out — that is, **reconstruct** — what had occurred in the past and how it had occurred. In this way, scientists have also tried to learn about living objects in the past, since the time they appeared on earth. Let us see what they have been able to find out.

(**a**) There were no living objects on earth when it was born. There were only elements.

(**b**) The earth was very hot in the beginning. Slowly, it cooled down. During this process, many compounds were made from the elements. Later, the continents (land), the seas and the atmosphere appeared. As time went by, the compounds necessary for life were made.

(**c**) A time then came when, very slowly, living materials started forming from the nonliving elements and compounds — that is, atoms and molecules. The atmosphere and other conditions on earth at that time were particularly suitable for this to happen. Such conditions do not exist on earth today. No new life is therefore being formed in nature on our earth today, from nonliving materials. Life alone can give rise to life now. The formation of living materials from nonliving materials in the past can be compared to the formation of compounds from

elements. In both cases, a more 'complex' object is formed from simpler ones.

(d) The nature of living organisms on earth has changed with time. For example, at one time we had large animals called dinosaurs living in the world. There was no man, no elephant and no lion at that time. Today we have a large number of human beings (nearly 4,000,000,000), and at least some elephants and lions Such changes continue to occur even now. In fact, many kinds of living organisms that we see today may not be found on earth when our grandchildren grow up, unless we take special care to conserve them. For example, but for the timely action of the Government which banned killing of lions, the Indian lion that we can now see in the Gir forest in Gujarat, would have disappeared.

(e) The early living organisms formed on earth from nonliving materials were probably very simple. They contained only a small number and variety of cells. As time went by, some of these early organisms gradually gave rise to more complex forms containing a large number and variety of cells. We now find on earth about 1,000,000 or so different types of living organisms. They have all arisen from simpler organisms.

(f) New types of organisms arose on the earth from time to time as a result of several small changes in an existing organism, caused entirely **by chance.** We encounter 'chance events' all the time in our life. For example, if you throw a stone at random in the sky in open space, nothing is likely to happen most of the time. You may, however, hit a bird with that stone by chance.

(g) While new, complex living organisms were being formed from the older and simpler ones, some of the older organisms like the dinosaurs slowly disappeared from the earth.

(h) The disappearance of certain types of living organisms from our earth at various times appears to have been due to two main reasons:

(i) The environment became unsuitable for the organism. For example, if you bring a polar bear to spend the summer in Vijayawada or Delhi, the chances are that it will die, unless, of course, you take special care of the animal as is done in the zoos. (Remember, there was no one to take care of the dinosaurs the way we can take care of polar bears today!) A dog from a cold hilly area in India does not generally survive the heat of the plains. Many plants which grow in one part

of India will not grow easily in another part.

(ii) There was not enough food for all. Those, who won in the competition for food, got food and lived on. Those who lost, died. If living objects of one particular type kept on losing, a time came when none was left to produce more of the same type. The type then disappeared

3.5 Species

Living objects which show **large similarities**, such as those which exist between one man and another man, or one cow and another cow, are said to belong to the same **species**. For example, all men, women and children belong to the same species called *Homo sapiens*. Only the offspring produced by the members of the same species can reproduce their own kinds.

Individuals of the same type often wish to communicate with each other. Men communicate with each other through languages. Bees communicate with each other through dancing. Ants communicate with each other by touching each other. Many animals communicate with each other by secreting specific compounds which can be recognized only by animals of the same type Some other animals communicate with each other by making specific sounds which, again, can be recognized and understood only by animals of the same type. Can you name some such animals?

If you observe carefully, you will also notice that many living objects have a way of protecting others of the same type. In the case of more complex living objects such as man, cattle, birds and bees, this desire to protect is specially noticeable. Men do not generally fight each other. The wars you may have learnt about probably occurred because a **small number** of men were selfish.

You saw that we classified all human beings as belonging to the species *Homo sapiens*. Just as in measurement it is necessary to have a standard unit for communication with others (a unit which does not change from place to place), it is useful to have a standard name for every living species. Such names of living objects are called their **scientific names**. A tiger is called *Sher* in Hindustani, *Vyaghra* in Sanskrit, *Puli* in Telugu and Malayalam, and Tigre in French. The scientific name for tiger is, *Panthera tigris*, which is used by scientists all over the world.

4. ACTIVITIES

4.1 List all the plants and animals that you have heard or read about but which you have not seen.

4.2 List all the living objects that you have seen, and classify them in as many ways as you can. Try to fit them in one of the groups given in Set 1 under Interesting Information on page 205 Are there any objects in your list that you cannot fit in any of these groups? Try to find out what the living objects eat, where they live and what their other habits are.

4.3 Collect one plant and one animal. Try to list all the differences between them.

4.4 Collect any one living object and list as many features of the object as you can (such as shape, size, colour, nature of food, different parts of the body that you can see, food and other habits, and so on).

4.5 Collect five types of living objects (do include some plants) and maintain them for two to three weeks.

4.6 List the differences between the growth of a crystal and the growth of a calf or a plant.

4.7 List the differences between a piece of stone and a tortoise, between a cloud and a bird, and between a living tree and a dead tree.

4.8 Draw pictures of any two plants and any two animals **from memory**. Then compare the pictures with the live plants and the live animals. Did you forget to draw any important feature?

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Unity and diversity in the living world

We have seen that many different types of living objects exist on the earth. Like nonliving objects, they are also made of atoms and molecules, have weight, and occupy space. There are, however, several important features that all living objects possess, and which make them different from nonliving objects.

There exist a large number of differences among living objects. For example, they often differ in shape, size, habit, life span and structure. There are also important similarities between the different types of living objects. A close study of these

similarities leads us to classify all living objects into a small number of groups. All living objects belonging to a group share several important features.

5.2 Origin and evolution of life

All living objects have originated from nonliving material. The various types of living objects we see around us did not come into being all at the same time. The earlier types of living objects were very simple. Gradually, as time passed, more complex types came into existence. We have studied some of the features of the process by which this happened Man is the most complex of the living objects

Living objects which show **large similarities** (such as those which exist between one man and another or one cow and another) are said to belong to the same **species**. Human beings *belong to the species called Homo sapiens.*

5.3 Dangers for species

We have learnt that several types of living species existed in the past. At some time in history, they disappeared. We have recognized two causes for the disappearance — or **extinction** as it is called, of species: competition between the species and unsuitable environment. Several species that we see today will disappear for the same reasons unless special care is taken to protect them.

From experience of the past, we can conclude that if we, as a species, wish to continue to exist on earth, we must not make the environment dirty and polluted. We must also protect the plant and animal life around us, as without it we cannot live (Chapter 9). Remember, plants and many animals cannot protect themselves! We must also learn to protect each other and to avoid wars.

5.4 Uniqueness of man

It is important for us to understand that man has come to occupy a unique position amongst all living species **only because he combines in him certain qualities**. Some of these qualities are listed below:

Ability to use his two hands and work hard with them.

Ability to communicate with fellowmen through a language.

Ability to cooperate with other men, and to work in a group.

Ability to share fruits of labour.

Ability to produce new ideas and to discover new things.

Curiosity, that is, desire to know and understand what is happening around him.

Desire to do things properly and well.

Desire to accept change (for example, a change in habits, or a change in the use of materials) when it helps him.

Some other qualities are:

Courage	Self-discipline
Endurance	Sense of responsibility
Tolerance	Desire to help others
Truthfulness	Kindness
Honesty	Fairness
Loyalty	Sense of humour

As an animal, man is very weak. In a straight fight (say for food), a man is no match even for a dog. Man would have probably become extinct long ago if he did not possess the qualities listed above. Man has survived and reached his present position because of these qualities.

Therefore, if we wish our species to continue to inhabit this earth and maintain its position at the "top" of all living species, we must do our best to develop these qualities in ourselves and in others.

CHAPTER 9

STRUCTURE AND FUNCTION IN PLANTS AND ANIMALS

1. OBSERVATIONS

1.1 If you observe a plant, you will notice that all parts of the plant are not similar. They look different. Some parts, like roots, are found under the ground; some parts, like leaves, are found above the ground. Some parts, like flowers or fruits, can be removed from the plant easily and without killing the plant. Other parts, like the main stem, cannot be removed easily, and if removed, may kill the plant. List as many parts of plants as you can and indicate how you think they are useful for the plant, that is, what **function** they perform.

1.2 You will notice that animals also have different parts. Observe a lizard, a spider, a dog, a cow, a goat, a bird, a fish, a frog, a slug and an insect. Make a list of all the parts that you can see in these animals. Indicate the function you think these parts perform in each animal.

2. QUESTIONS

2.1 We can see only those parts which are on the outside of the plant or the animal. Are there any parts **inside**?

2.2 Why do plants and animals have so many parts? What do these parts do? Do they help the plant and the animal in any special way? What will happen to the organism if we remove any of these parts?

2.3 Most of the plants may have the same **parts** — a root, a stem, a leaf or a flower but they may look different in different plants. Can you identify plants by looking at just one of these parts, say, leaves? Does a part (such as a leaf or a flower) perform the **same**

function in all plants?

2.4 Different animals also seem to have similar parts. All the animals we listed above have a mouth, though the mouth looks different in each case. Does a part (such as a mouth) perform the **same** function in all animals?

3. LET US FIND OUT

3.1 Plants

Scientists have studied a large number of plants This study has shown that many different species of plants have certain common parts. These parts differ in size and shape and in several other features, yet they perform the same function and are found at similar places in most plants. Table 1 (See page 135) gives a list of these parts and tells you what they look like, where they are located on the plant, and what they do.

3.2 Modification of plant parts

In some plants, a particular part performs a function **different** from that it usually does in most other plants. In such cases, the part looks different, too. Such parts are called **modified parts.** Some modifications of plant parts are listed in Table 2 (See page 141). You may be familiar with several of them.

3.3 Parts of some common animals

As you now know, there is a very large number of species of animals, and these species differ from one another in many ways. Different species also differ in the appearance and the structure of their parts and also in the function that these parts perform.

We give in pictures **P1** to **P9** the drawings of eight common animals. For each animal, two drawings are given. One drawing gives the location and the main function of the parts that you can see from outside (the **external parts**). The other drawing gives the location and the main function of the parts that are **inside** the animal, and that you cannot see unless you cut open (that is, **dissect**) the animal.

If you look at these pictures in detail, you can make several interesting observations. Some of them are given below:

(a) You will notice that some parts are present in all animals shown in these pictures. Some such parts are: skin, mouth, intestines, heart, brain and blood vessels.

(b) Some parts are present in some

animals but not in others. Examples of such parts are: hair, external ears, feathers, scales, wings, claws, legs, nipples, bone and tail.

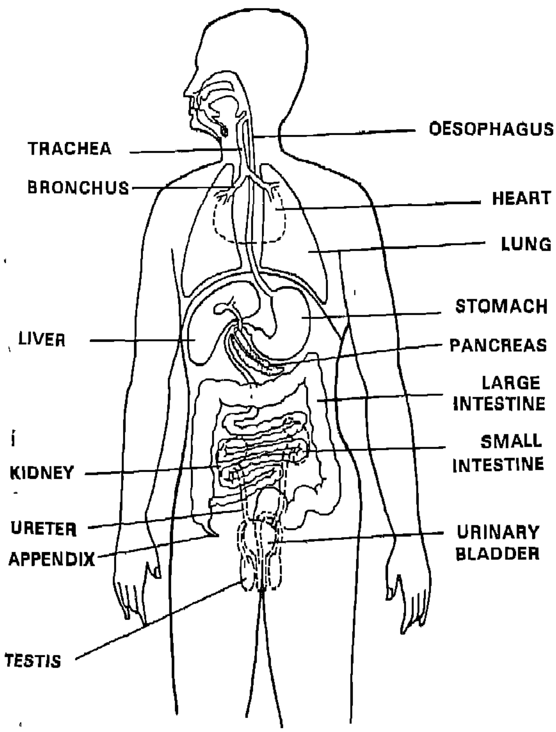
(c) You will notice that the same part is located at a different place in different animals. Some examples are: mouth, arms, legs, heart, nerves and nipples.

You can find other examples of such parts in pictures **P**1-**P**9, or from your knowledge of other animals.

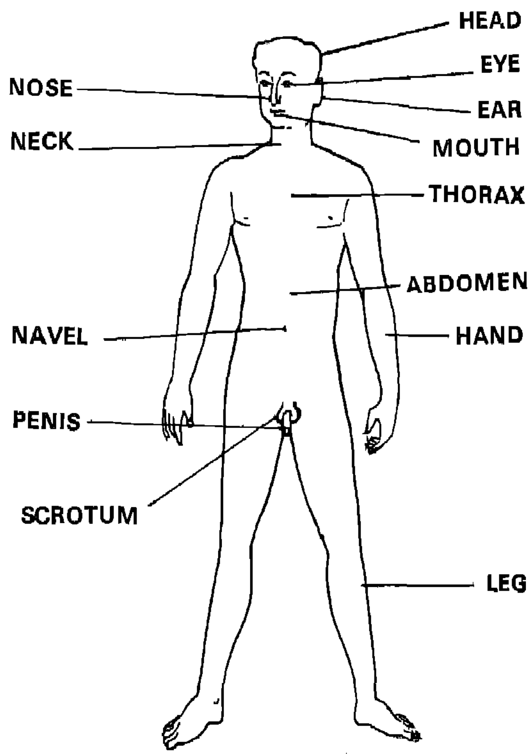
Name of the animal: Man

Group of the animal: Mammalia

Size: 175 cm. (If you magnify the picture **P**1b 19 to 20 times, you will get the size of this animal.)



PICTURE 1a

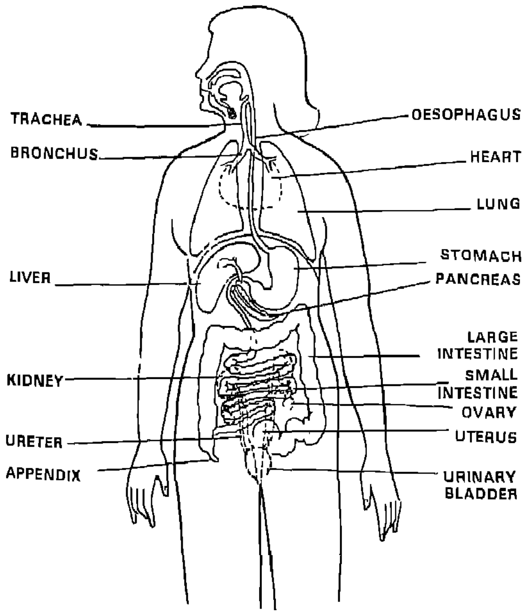


PICTURE 1b

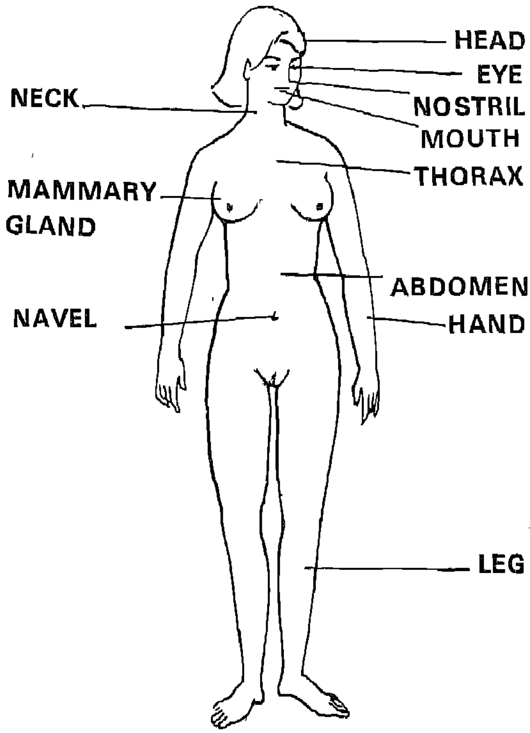
Name of the animal: Woman

Group of the animal: Mammalia

Size: 150 cm.(If you magnify the picture **P**2b 16 to 17 times, you will get the size of this animal.)



PICTURE 2a

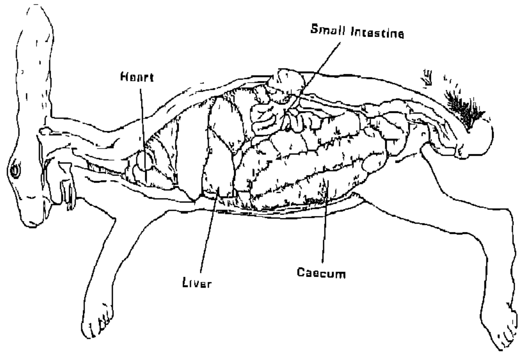


PICTURE 2b

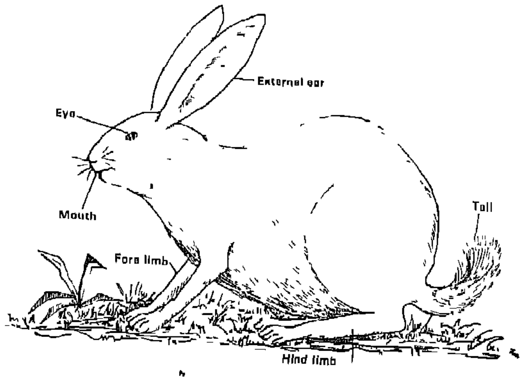
Name of the animal: Rabbit

Group of the animal: Mammalia

Size: 40 to 50 cm.(If you magnify the picture **P**3b 6 to 7 times, you will get the size of the animal.)



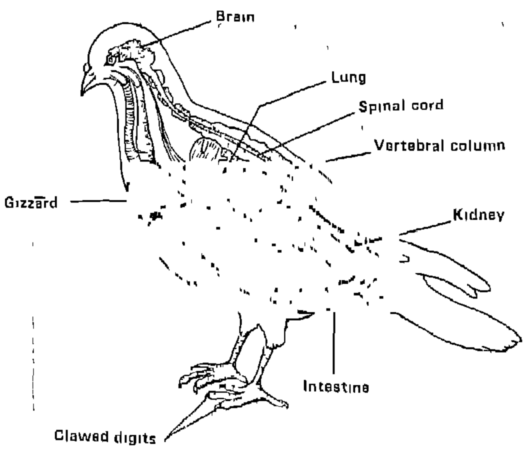
PICTURE 3a



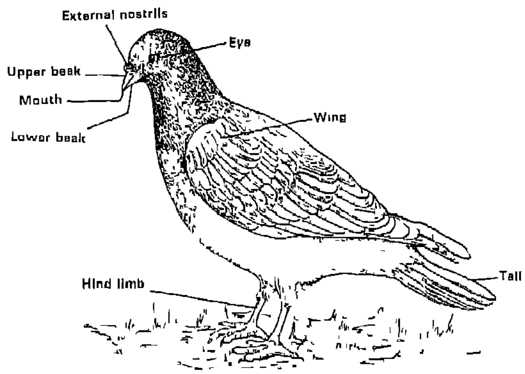
PICTURE 3b

Name of the animal:	Pigeon (male)
Group of the animal:	Aves

Size: 20 to 25 cm. (If you magnify the picture **P4b** 3 to 4 times, you will get the size of the animal.)



PICTURE 4a

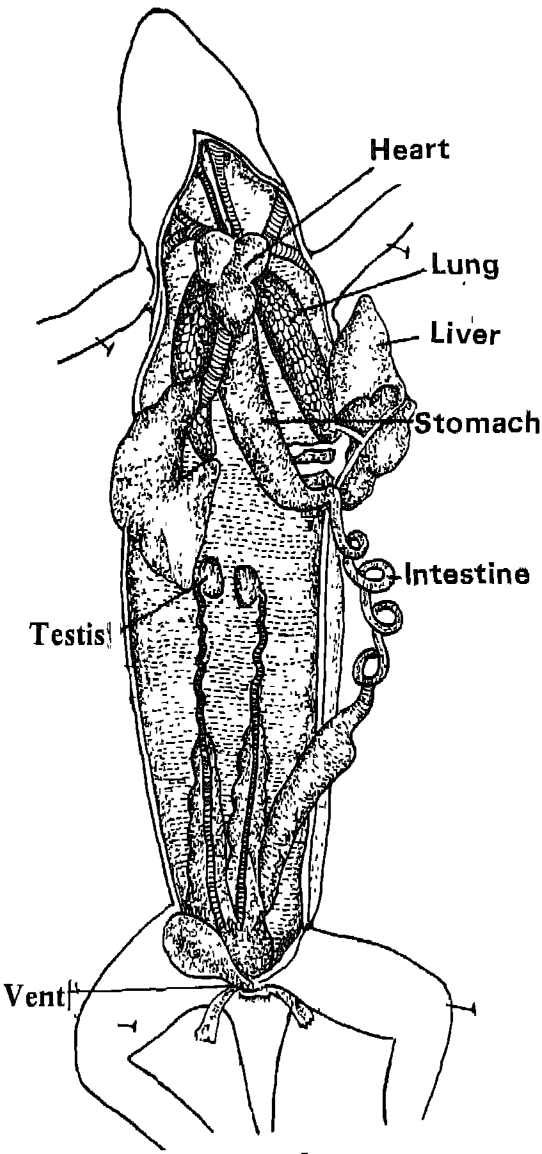


PICTURE 4b

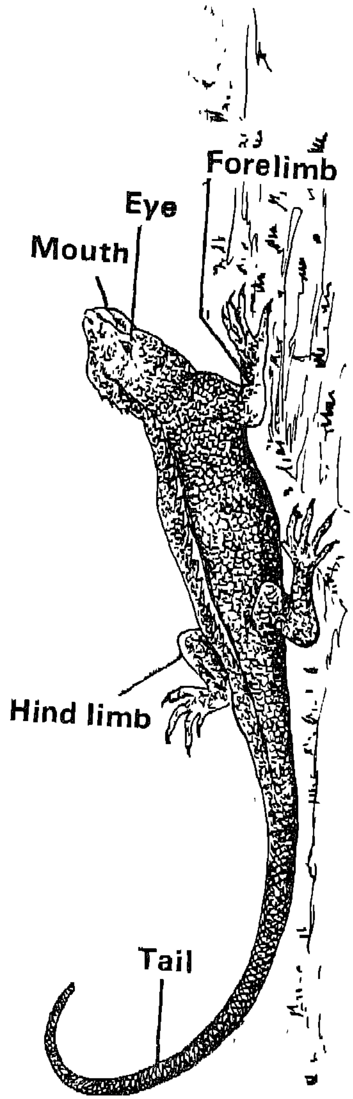
Name of the animal: Lizard (male)

Group of the animal: Reptiles

Size: 12 to 14 cm. from snout to vent (If you magnify the picture **P5b** $1\frac{1}{2}$ to 2 times, you will get the size of the animal.)



PICTURE 5a

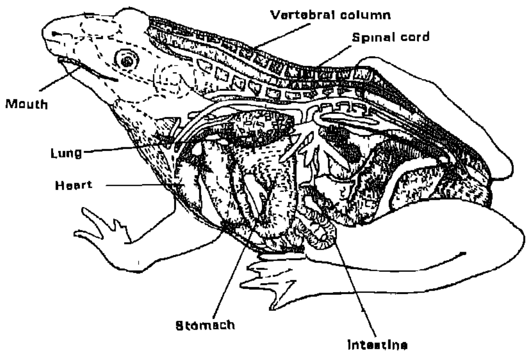


PICTURE 5b

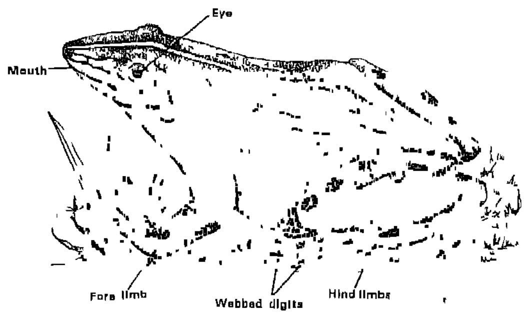
Name of the animal: Frog (male)

Group of the animal: Amphibia

Size: 15 to 18 cm. (If you magnify the picture **P6b** 2 to $2\frac{1}{2}$ times, you will get the size of the animal.)



PICTURE 6a

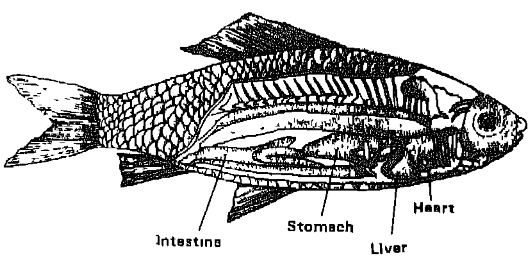


PICTURE 6b

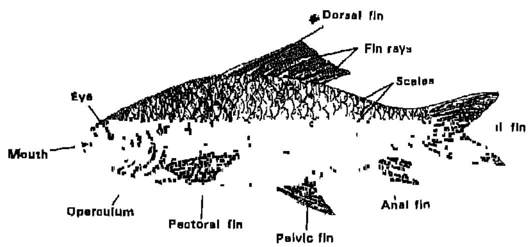
Name of the animal: **Rohu** fish (female)

Group of the animal: Pisces

Size: 100cm. (If you magnify the picture **P7b** 12 to 14 times, you will get the size of the animal.)



PICTURE 7a

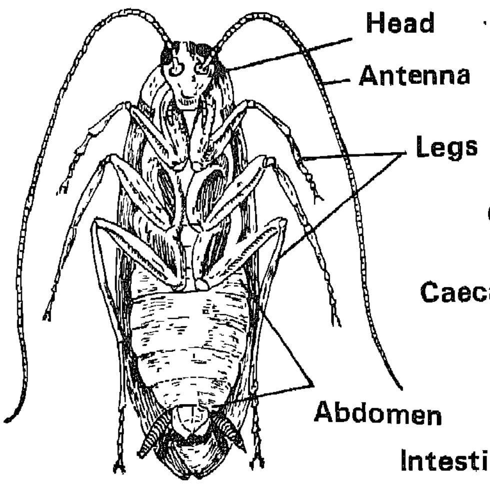


PICTURE 7b

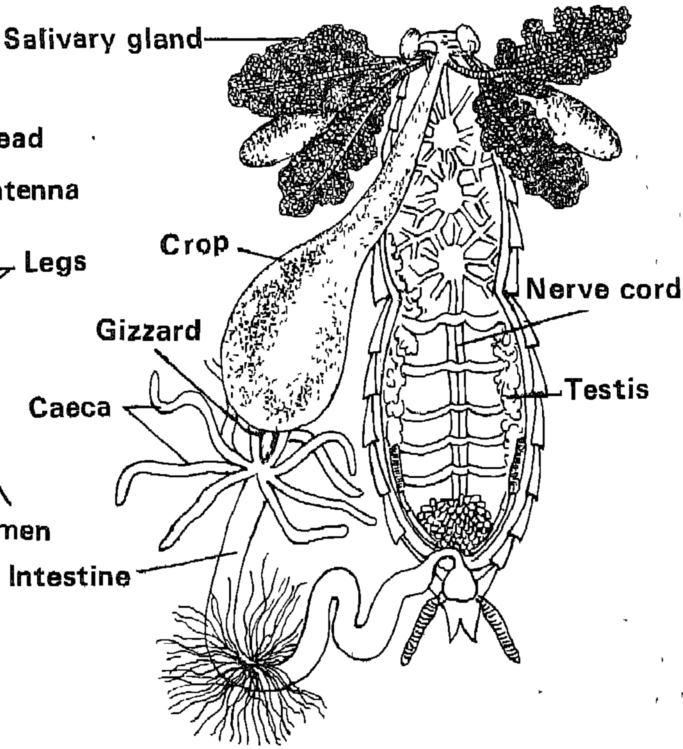
Name of the animal: Cockroach (male)

Group of the animal: Arthropoda

Size: 3.5 to 4 cm. (If you reduce the picture **P8b** to half its size, you will get the size of the animal.)



PICTURE 8b

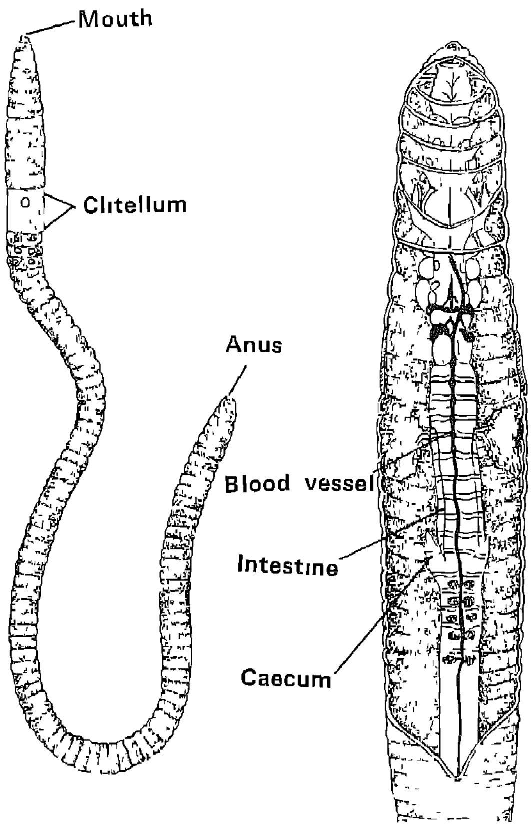


PICTURE 8a

Name of the animal: Earthworm

Group of the animal: Annelida

Size: 20 to 25 cm. (If you magnify the picture **P9b** $1\frac{1}{2}$ times, you will get the size of the animal.)



PICTURE 9b PICTURE 9a

3.4 Effect of removal of parts

Animals and plants have many parts which perform different functions. What would happen if one of the parts were destroyed or removed?

Removal of a part has different effects on different animals or plants. In general, some parts can be removed from certain animals or plants without any discomfort or harm to them. In the case of some other parts, such removal is harmful. Removal of certain parts may not affect the individual immediately, but may have an effect later In the case of certain other parts, removal or destruction would cause immediate death of the individual.

Let us take one example each from the animal kingdom and the plant kingdom. (We should remember that what is true for the species we select may not be true for another species.)

Let us take man as an example from the animal kingdom. Removal of the appendix does no known harm to man. Removal of one eye or one hand or one leg would immediately reduce the capabilities of a man, although he may continue to live and do useful work. Removal of one kidney or one lung may not have any effect on the person immediately but he may suffer later if the remaining kidney or lung becomes diseased. Removal of heart or brain will kill the man instantly.

As an example from the plant kingdom, let us look at a mango tree. Removal of a few leaves or branches, or of all the flowers or fruits, will not harm the tree in any way. If we cut too many branches and pluck most or all the leaves, the tree may not die, but may cease to be healthy. You must have seen such 'sick' trees. If we remove all the roots, the mango tree will soon die. Plants do not appear to die immediately no matter what part is removed.

3.5 Reproduction

(**a**) We know by now that all living organisms can produce more of their kind (**P10** and 11); if they did not, they would have become extinct! should, therefore, study it in some detail.

PICTURE 10

(**b**) We also know that many living species — such as man(*Homo sapiens*), horse, and birds — consist of two types of individuals; male and female. Production of more of their kind, called **reproduction**, needs cooperation between the male and the female of the same species. As the continuation of a species depends on reproduction, it is a specially important function of living species. We

(**c**) The male of the species produces a special type of cell called the male reproductive cell or the **sperm.** The female produces another special type of cell, called the female reproductive cell or the **egg.** You have seen eggs of various species of animals: hen's eggs and the eggs of birds, lizards and cockroaches, to give a few examples. While the sperms are very minute and cannot be seen with the naked eye, the eggs are generally much bigger. Ostrich's egg is the largest egg known. In fact, it is the

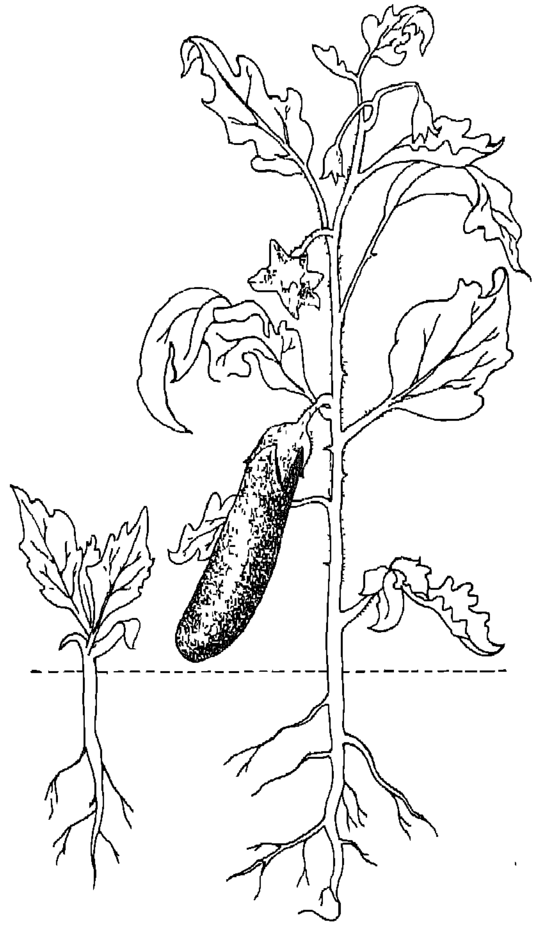
largest known cell. It is nearly 20 cm in diameter.

In many species (such as man, birds, fishes and several plants like the papaya plant), a new life begins — that is, a new individual of the species comes into existence — when the male and the female reproductive cells of the same species come together and unite to form one cell. We all began our life as such — a cell which was formed, when one sperm cell of our father and one egg cell of our mother came together. When we were **just** formed in this manner, we could barely be seen with the naked eye!

(**d**) There are several interesting features of reproduction in certain living species. For example, in many plant species, both the male and the female reproductive cells are produced by the same individual. This happens in certain animal species as well, such as the earthworm.

Some living species, like bacteria, do not need special reproductive cells to reproduce. They simply eat enough, grow bigger, and divide into two!

In the case of many plants (potato, sweet potato, croton, rose, mango, banana, dahlia, chrysanthemum, sugarcane, grape, bamboo and all cacti, to name a few), one can grow another plant of the same species by



PICTURE 11

simply taking a suitable part of one plant and putting it in the soil. This kind of reproduction is called **vegetative propagation**. The reproductive cells are not needed for this kind of growth. In fact, many plants, such as banana, can grow **only** in this way.

(**e**) You must be familiar with a variety of seeds: mango seeds, guava seeds, gram, peas and all pulses (*dals*). What **is** a seed? A seed is, in fact, an

immature plant that stopped growing some time soon after the two reproductive cells came together.

Seeds show two interesting properties. First, they can stay in their state of 'suspended growth' for a very, very long time. The time for which seeds can stay in a state of 'suspended growth' differs from species to species.

Secondly, seeds when given water, air and the right temperature, start growing again. The early state of this growth is called **germination**. A seed which has germinated will grow into a mature plant, if given enough food and care.

3.6 How do species spread from place to place?

There are many plants and animals that are found today in many countries, but were not there in the past. How did they spread from one place to another? Living species have spread in several ways:

(**a**) The species themselves move from place to place. For example, people from Europe moved to America to settle down there only a few hundred years ago. Many animals have moved in this way in the past to places where more food and better living conditions were available.

(**b**) When man moved from one place to another, he took with him many animals and plants and bred them. Some of the species that have spread in this way with man are animals like dogs, cattle, horses and rabbits; vegetables like potato, tomato and chillies; and other plants like tea, rose and tobacco. Five hundred years ago, there was no potato, tomato or tobacco in India; no tea and tobacco in Europe and no rabbit in Australia. Today you find these species every where in the world including India, Europe and Australia. Man has been responsible for spreading them so widely.

(**c**) The seeds, flowers and several other parts of plants are often carried by birds, insects, water or air from one place to another. You may have seen how silk-cotton seeds and flowers are carried by wind. Bacteria and other smaller germs also spread in this way.

3.7 How do they collect information?

Living species gather information about their environment and respond to it in various ways.

You may have seen how some insects and worms 'curl up' when you touch them. Animals like dogs and human beings, collect information through the five 'senses': seeing, hearing, smelling, tasting and touching.

The five sense organs are eyes, ears, nose, tongue and the skin Information collected by the sense organs travels from the organ to the brain where it is stored. The brain may then order the organism to react to the information in a certain way. The brain also allows you to **recall** the stored information. This is the basis of memory The brain enables you to make decisions too. If you drop a potato from a bag in the middle of a road, it tells you to pick it up. But if a car is approaching you at that time, it tells you not to worry about the dropped potato and run!

Plants do not have a brain. If a mango tree drops a mango, it cannot pick it up!

Some animals and plants may not have eyes, ears, or a nose like us, but they also collect information and respond to it.

3.8 Even bees can talk

Communication between one individual and another is a special feature of many living species. Men communicate by talking or writing, bees by dancing, and ants by touching When a bee finds out a store of food, it goes to its friends and dances before them in a certain way. From the dance, the other bees know where **exactly** the food is and how much food there is. Dance is, therefore, the language of the bees.

Occasionally, one species can communicate with **another** species. You know how you can make a pet dog understand and do what you want. You also learn to understand **its** wishes!

4. ACTIVITIES

4.1 Choose a few plants of your liking. List as many different parts as you can of these plants. What function do you think these parts perform? Which parts are common to all the plants you have selected? Which are not? Is there a part in any of these plants, which performs a function different from the usual?

4.2 The male reproductive cells of a flowering plant develop from **pollen grains**. The pollen grains occur in the flower. If you shake a flower on a paper you will often note that a powder (generally yellow, white or brown) collects on the paper. This is pollen. Collect the pollen from as many different types of flowers as you can.

4.3 Collect as many different types

of seeds as possible and label them. Do you notice any variation in the shape, size and weight of the seeds. Open some of them and record what you see inside.

4.4 Plant some of these seeds in a pot or in the ground. See what happens to the seeds. Observe them every 24 hours for a week and record as many changes as you can. Do all seeds grow in the same way?

4.5 Try to grow one or two plants directly from their cutting (**vegetative propagation**). Money plant, croton, bougainvillaea and many cacti are amongst the plants which will grow easily from a cutting.

If you choose money plant, take a small piece (leaf plus stem) and put it in an open bottle half full of water; part of the stem should be immersed in water. Record your observations every day for two weeks.

4.6 Collect any one of the following animals: a fish, a frog, a grasshopper, a lizard, a cockroach, or an earthworm.

Observe and record all its external parts. What functions do you think each part performs in the animal?

4.7 Select any flowering tree in your school or in your neighbourhood. Record all the living species (such as insects, birds and other plants) found within 10 metres of the tree all around.

4.8 Out of the animals you know, list separately those which have toes and fingers and those which have not.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Structure and function

We have learnt that every plant or animal has many parts which perform different functions. You will learn later that each part is composed of different substances. In the living world, structure, function and composition are always related.

Some parts are present in a large number of animals, while other parts are present only in some animals. In the case of plants, the main parts we have studied are present in almost all of them, excepting bacteria, algae, fungi, mosses and ferns.

A particular part can perform different functions in different species. You may find it interesting to look for plants or animals in which the same part performs different functions in different species.

We have also learnt how animals and plants reproduce.

5.2 Disease

We should realise that both plants and animals can be affected by disease. Can you name some such diseases? Disease usually affects one part of the organism first. Very often, if one part is hurt or damaged, there is an effect on several other parts as well. Therefore, a disease affecting one part, if not cured soon, usually affects the whole animal or plant. We should, therefore, do our best to **prevent** the occurrence of disease. If a disease occurs, we should not neglect it but try to have it cured **as early as possible.**

5.3 The unwanted plants

We know that many plants are of special use to man. But there are also plants, like weeds, which do a lot of harm. Weeds usually grow faster than the useful plants, leaving very little food for the plant. There are now methods available to destroy weeds and other unwanted plants. You may like to learn about these methods.

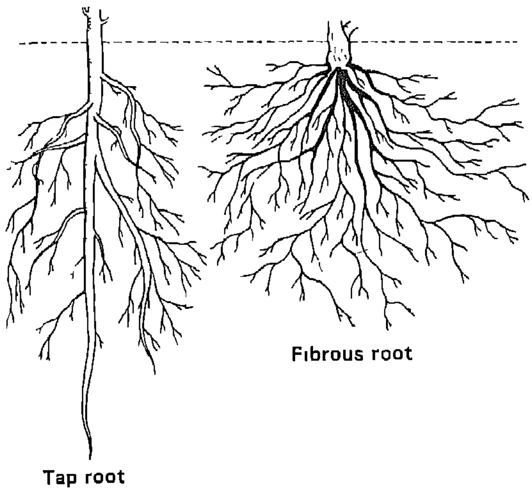
5.4 Like breeds like

You would have realised that the plant we would obtain from a seed would be very similar to the plant from which the seed came. A good seed will give you a good plant. While growing useful plants, such as grains, pulses, vegetables and fruits, we should try to sow the best seeds available. In our country there are special places, often run by the Government, from where one can obtain good seeds.

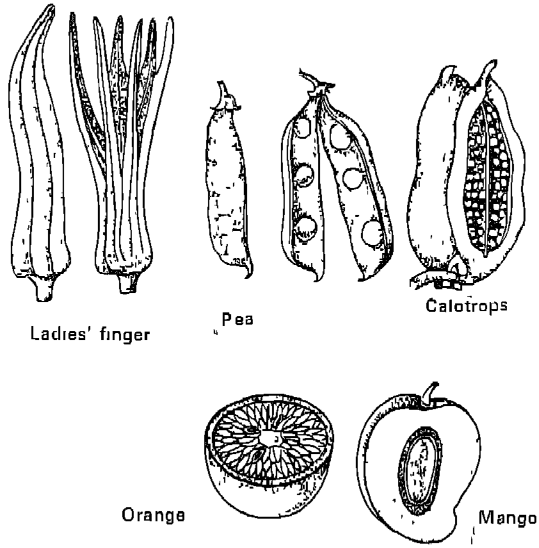
TABLE 1
PARTS OF A PLANT

Part	*Appearance*	*Position*	*Function*	*Special features*
(1)	(2)	(3)	(4)	(5)
Root (P12)	Roots are usually elongated and cylindrical, gradually tapering towards the	Roots usually occur below the soil. Sometimes, they may be found in other positions to	The root helps in drawing water and nutrients from the soil. It keeps the whole plant in	When the seed grows into a plant, the first part that comes out is the root. This is the **primary** or the

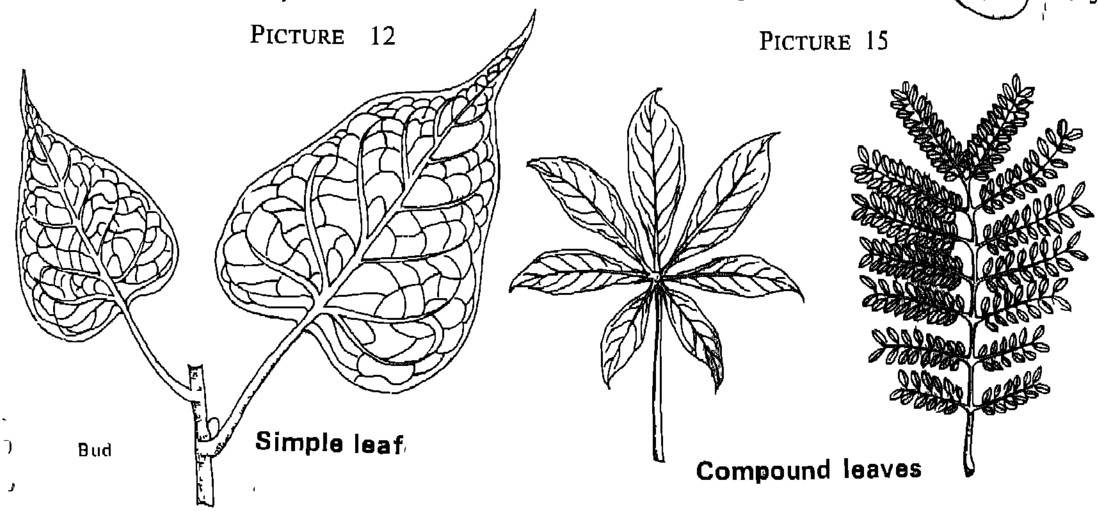
	tip They are non-green in colour. Roots bear branches which are similar to the root These branches grow downwards into the soil and are called branch roots The important parts of the root are the root cap at the tip the growing region which is just above the tip, and a number of single-celled **root hair.**	solve a special problem of the plant	position	**first** root In pea or gram plant, or mango tree, the first root grows and becomes the main, **tap** root. It gives out branches. In paddy or wheat plant, or coconut tree, the first root dies but a large number of other (**fibrous**) roots appear and stay.
Stem	Stems are usually cylindrical in shape. Their colour is green when the plant is young The stem normally grows upwards in the air; it always has **nodes** and **internodes.** From the nodes	The stem usually occurs above the soil Sometimes, the stem may be found in other positions to solve a special problem of the plant.	The stem normally helps in carrying water and nutrients from the root to the leaves It also carries the prepared food from the leaf to other parts of the body. The stem supports branches,	The stem may be soft or hard (woody) or it may grow into a very thick trunk Plants with soft stems are called herbs and creepers. Plants with thin, woody stems are called shrubs. Plants with a thick trunk are called



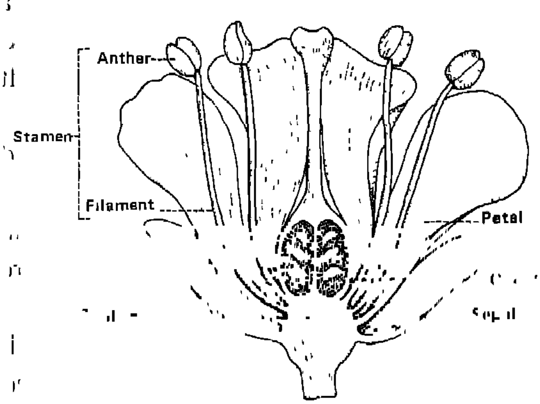
PICTURE 12



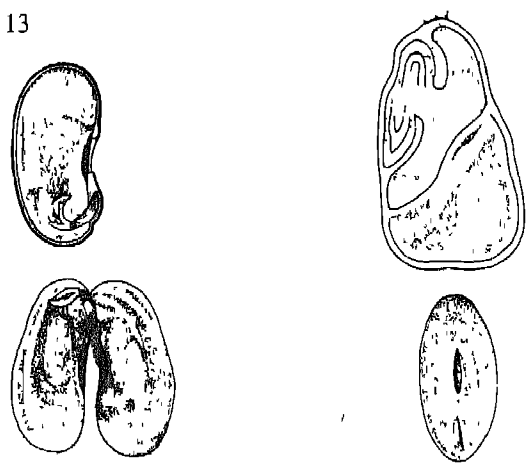
PICTURE 15



PICTURE 13



PICTURE 14



PICTURE 16

	sideways grow **branches**, which bear leaves, flowers and fruits Branches are also stems, like the main stem, they may also bear leaves, flowers, and fruits.		leaves, flowers and fruits.	trees
Leaf (**P** 13)	Leaves are usually green and flattened They look very different from the stem or the branches, and always arise from the node of a stem. A special part of the stem, called the **bud**, is always present near the base of the leaf The leaf has three parts — the **leaf base**, the **stalk**, and the flattened **leaf-blade**.	Leaves grow out of the stem sideways in the air.	The leaf helps in the preparation of food from the water and the other nutrients it obtains from the soil through the stem and the root, and the carbon dioxide gas it obtains from the air. The plants 'breathe' mostly through their leaves The excess of water that the plant may want to get rid of, evaporates into the air from the leaves.	In some plants, the leaf is simple. It consists of just one whole leaf-blade. In other plants, the leaf is not simple. It consists of several small pieces (**leaflets**).

Flower (P14)	The flower is very often the most attractive part of a plant. Usually, the flower is brightly coloured. It consists of four circles of different looking parts, arranged on a platform-like structure, called the **thalamus**. The outermost circle consists of green leaf-like structure, the **sepals**. The second circle consists of **petals** which are the showy part of the flower. The two inner rows — where male and female reproductive cells are made — are called **stamens** and **carpels**.	Flowers like leaves also grow sideways from a branch or the main stem. They grow from a special kind of bud — the **flower bud**.	The flower helps in reproduction. The two outer rows of the flower — the sepals and the petals — protect the inner parts. Petals attract insects. The male and female reproductive cells of plants are made in the flower. These cells also come together in a flower; this flower may or may not be the same flower in which the cells were made In all cases, however, the female cell always stays in the same flower in which it is made Only the male cell may move	In some flowers, two or more of the rows may be brightly coloured. Some flowers have only the stamen **or** only the carpel.

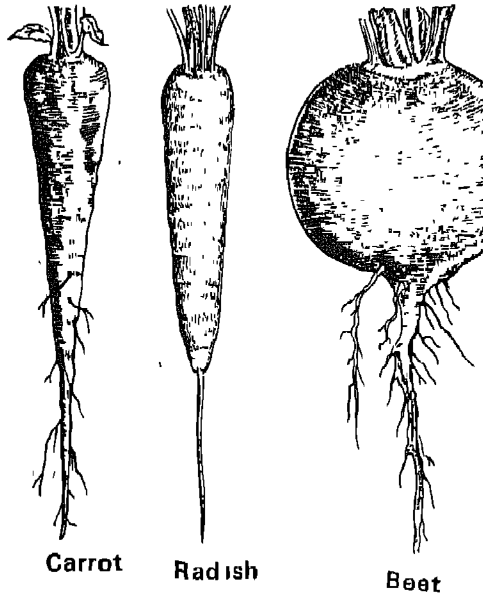
Fruit (P15)	The fruits of different plants are of different colour, shape and size. In the case of certain plants, certain parts of the fruit are fleshy and can be eaten. A fruit grows and develops out of a part of the flower's carpel (ovary). It consists of three layers of walls, and the growing seeds.	The fruit, being merely a part of the flower which has changed its appearance and function, is in the same position as the flower.	The fruit protect the seeds and help in spreading the seeds away from the plant	
Seed (P16)	Seeds in different plants are of different shape, size and colour. Usually, the seed has two seed coats The inner seed coat encloses the very young 'sleeping' plant. It also contains some food stored for future use of the young plant	Seeds are located inside the fruits. Their position within the fruit varies from plant to plant	Seeds allow more plants of the same type to come up at other places (we can carry seeds more easily than plants, from one place to another).	

	The young plant in the seed has already a minute stem, a minute root and one or two leaves The food may be stored in the leaves or elsewhere in the seed.			

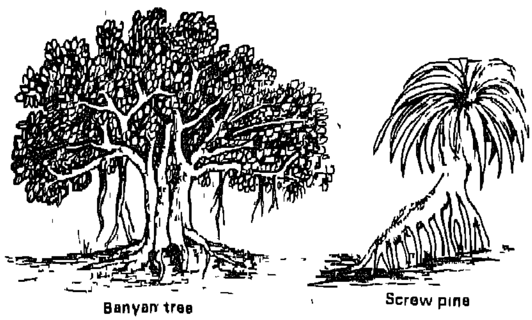
TABLE 2

SOME MODIFICATIONS OF PLANT PARTS

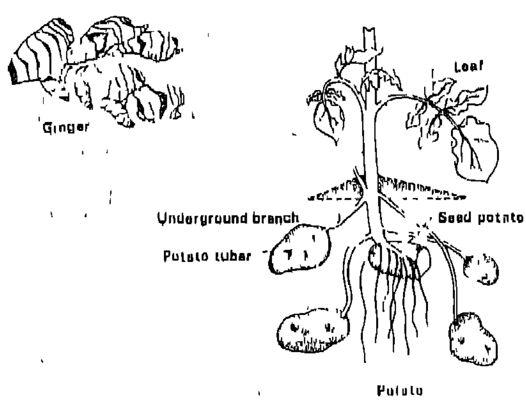
Part modified	*Appearance of the modified part*	*Position of the modified part*	*Function of the modified part*	*Examples*
1	2	3	4	5
Root (P17 and 18)	**(a)** The modified root has a shape and appearance different from the normal root, the modified root may be: **i)** almost ball-like, abruptly tapering at both ends.	Always underground. **i-iii** are modifications of the main root of the plant. **iv** is a modification of the fibrous root.	Storage of food for future use.	**i)** Beet **ii)** Radish **iii)** Carrot **iv)** Asparagus



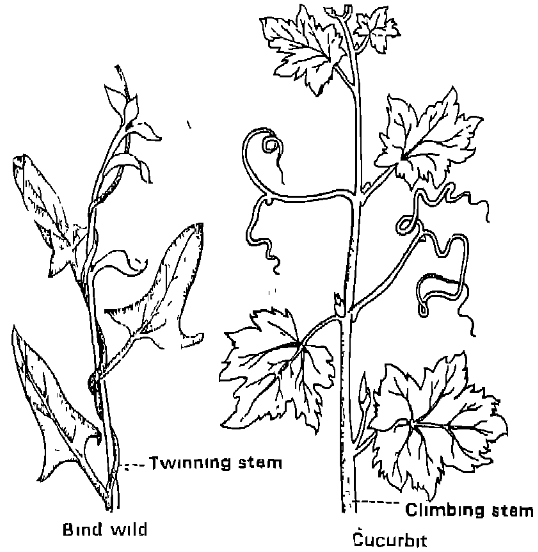
PICTURE 17



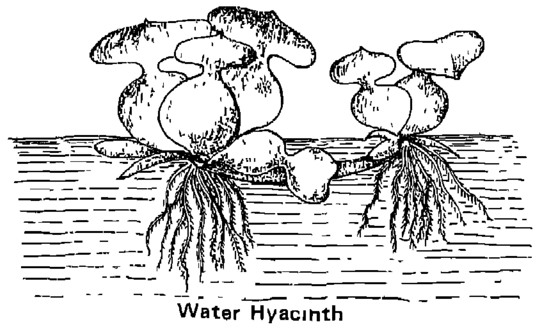
PICTURE 18



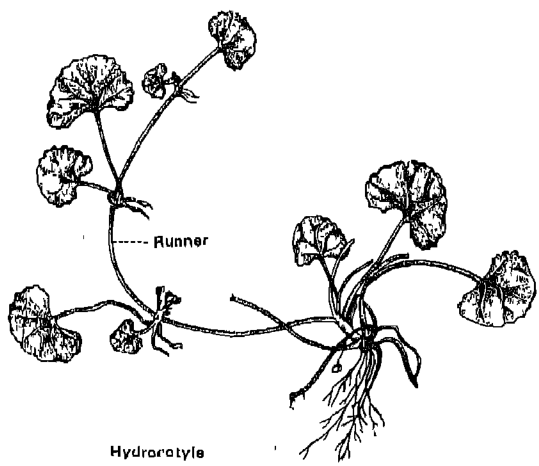
PICTURE 19



PICTURE 20a

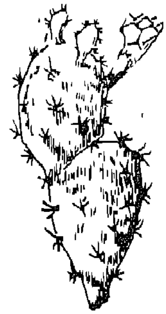


PICTURE 20b



PICTURE 20c

	ii) spindle-shaped, iii) cone-shaped, or iv) hanging in a cluster			
	(b) The modified root is stout and straight.	Arises from the node of the main stem or from branches above the ground, and grows downwards — straight or inclined — into the soil.	To provide additional mechanical support to the plant.	Banyan tree Screw pine
Stem	(a) The modified stem looks similar to the root owing to its non-green colour and the underground position.	Always underground Grows from the underground part of the main stem or a branch.	Storage of food for future.	Potato Ginger (**P**19)
	(b) The stem is thin and thread-like in appearance; it coils or twines round a support.	Above the ground. Arises from the exposed part of the main stem or a branch.	Climbing.	Stem tendrils of gourd Passion flower Bind wild (**P**20a)
	(c) The stem has a normal, stem-like appearance, but it appears as a horizontal connection	Grows just above or below the surface of the soil or water.	Vegetative propagation (multiplication without a sperm and an egg coming together).	Hydrocotyle (**P**20c) Marsilia Chrysanthemum Water hyacinth (**P**20b)

	between two plants.			
	The stem becomes green with varied appearance, such as fleshy, flattened, ball-like or cylindrical. The modified stem bears spines (modified leaves) all over the body.	Occurs above the ground	Preparation of food. Performance of the function of leaf in desert climate	All cacti (P21)  A Cactus
Leaf	(a) The leaves have a thin, thread-like appearance, They reach out for a support and twine around it after they have found one	Occurs attached to the main axis of a compound leaf Arises from the leaf base	Helps the plant to climb	
	(b) The leaves are hard, pointed and thorn-like; they are not green	Occurs attached to the green fleshy stem	Defence against invaders (that is, other living species). Prevention of excessive loss of water in dry climate (this is made possible by the small surface of the leaf).	Spines of the cacti

CHAPTER 10

FOOD AND HEALTH

1. OBSERVATIONS

1.1 All living species need food. Let us take the case of man first. You know how you feel when you have not had food for some time. If you do not eat food continuously for a few days, you would lose weight. Adults need food to be able to live, that is, to maintain themselves. Children need food for growing as well.

This is also true for all other living species. Your dog and cat need food. Puppies and calves need food to grow. All animals need food.

Plants, too, need food: we give food in the form of water, manure and air to the plants we grow in the garden. Other plants obtain their food from the soil and the air without our help. We see plants drying up due to lack of water. When there is no rain, our fields dry up and the crop is lost. Water is an important food for all living species.

Similarly, insects, fish, birds, bacteria, and all other living species, need food.

If food is not given for long, most of the known living objects will die

1.2 If we do not eat food for a day, our ability to do physical work goes down. We get back this ability — or energy as we say — after we have eaten.

1.3 Different living species use different kinds of food. Can you think of some examples? What is it that a cow can eat which you cannot?

Dogs eat raw meat which may make you sick. Amoebae live on bacteria and other very small living organisms. A king cobra would eat only snakes. Scaly ant-eaters and armadillos — both large animals — eat only white ants and other soft-bodied insects. Some birds, like the kingfisher, eat only fish. Some other birds, like the wood-pecker, eat only insects. Some, like the pigeon and the parrot, are 'vegetarian'.

1.4 We often find that even though an individual member of a living species **can** eat many different kinds of food, it shows a preference or a liking

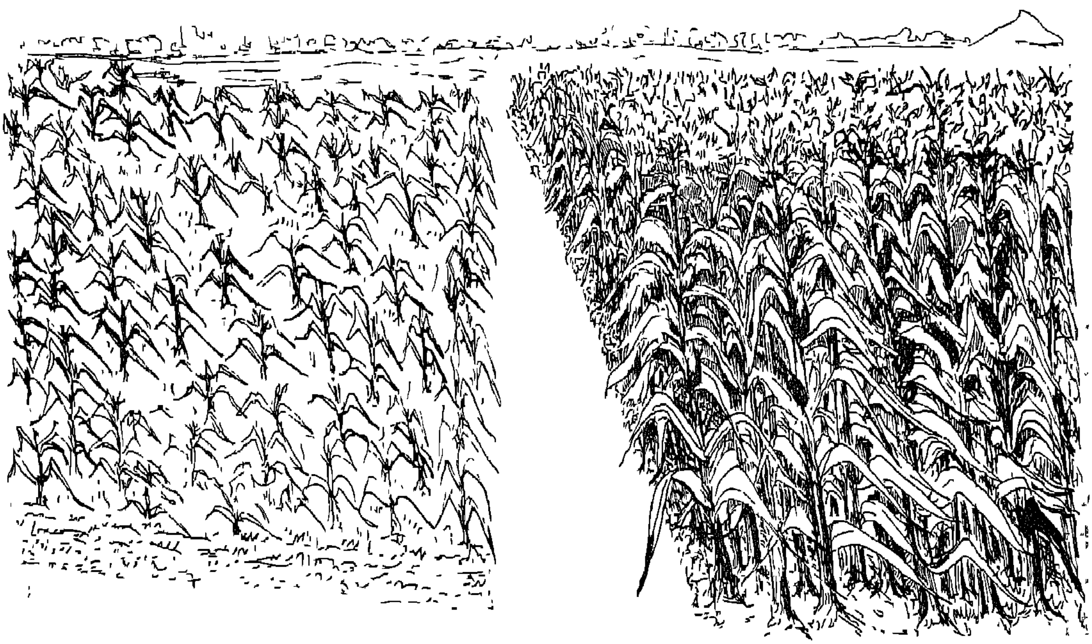
for certain foods. You may prefer to eat rice. Others in our country may prefer to eat wheat. You may relish eating prawns; many others may not.

1.5 In the case of some species all members of the species show a preference for certain food. For example, we all know that a cat enjoys drinking milk. Can you tell which species show preference for some food? Prepare a table showing the species and the foods preferred by them. Also indicate in the table, the other foods they would eat if the food preferred by them were not available.

1.6 Different living species eat their food in different ways. For example, the kingfisher swallows the fish it eats; it does not chew the fish. Most birds do the same. For man, on the other hand, it is essential that he chews the food first. A cow first swallows the food; it then leisurely brings it out, chews it and swallows it again. If you observe carefully around you, you may find interesting variety in the manner in which various animals eat their food.

1.7 Some people are fat; some are thin. Some people are strong; others are weak. Similarly, some plants look healthy, while some look sickly. Observe around you and make a list of individual plants which are, in your opinion, healthy, and plants which look sick.

In the picture below (**P** 1), you see two wheat crops. One belongs to Rais and the other to Munis. Rais has



PICTURE 1

spread fertilizers and manure in his wheat field. Munis has not done so. Can you say by looking at the two crops, which one belongs to Rais?

2. QUESTIONS

2.1 Why do living things have to eat? In other words, why is food necessary?

2.2 Can we eat any kind of food? If we can, **should** we eat any kind of food?

2.3 Do all living species need the same kind of food?

2.4 Why are some people fat, others thin; some are strong, others weak?

3. LET US FIND OUT

3.1 Why do we have to eat?

Food is needed by all living species for four main purposes:

(**a**) An important function of food is to help living organisms grow. If enough food is not given, or it is not of the right kind, growth will not be sufficient or healthy.

(**b**) We know from daily experience that objects such as a cycle tyre, clothes or a tooth-brush, wear out with usage. Parts of living objects also wear out in the same way. Food is needed by living objects for **replacement** of the worn-out parts. For example, our skin wears out fast and is being constantly replaced. Snakes shed their entire skin from time to time. Many of you would have seen such shed snake skin. The red cells of our blood also die out fast on account of wear and tear and are replaced every six weeks.

(**c**) Food is also needed by living objects for **repairing** their damaged parts. For example, if you have a wound, a burn or a cut on your skin, a part of the skin is destroyed. We know that very often the injury heals completely. During the process of healing, new skin is formed. We need food for the formation of the new skin.

One-third of your liver can be removed by surgery. The remaining two-thirds of the liver will grow back to the normal size in a few weeks, if you are healthy and eat enough food.

(**d**) The fourth important function of food is to provide energy. We need energy for movements such as

running, walking or raising our arm. We use more energy when we run than when we walk. We use less energy when we **sleep** as our movements are small when we are asleep.

Only a small number of materials present in our food are used by the body unchanged. The rest of the materials are converted by chemical reactions into thousands of other materials that the body needs. Energy is also required for this purpose.

Energy is 'hidden' in the materials present in the food we eat. Our body — as that of all other living organisms — knows how to draw out this energy and use it for the purposes we have mentioned above. Some types of food materials have larger amount of usable energy hidden within them than others. For example, 100 grams of potato will give you more energy than 100 grams of grapes.

3.2 Essential nutrients

We have just learnt that living systems are made of a large number of different compounds. Some of these compounds cannot be made by certain organisms from materials contained in food. Such compounds that a living organism cannot make — or make in insufficient quantities — are called **essential nutrients**. They have, therefore, to be supplied to the living organism in a ready-made form in the food they take. For different species, different nutrients may be essential. For example, several compounds, called **vitamins**, are essential nutrients for man

Good food for a species (**i**) is rich in essential nutrients, (**ii**) provides just enough raw material (no more or no less) to take care of the needs of growth, replacement of worn-out and damaged parts, and (**iii**) provides the energy required by the body.

3.3 Balanced diet

If you eat less than your body needs, you will gradually become thin and weak. If you eat **much** less than your body needs, or if your food does not contain an essential nutrient, you will become ill that is, suffer from a disease.

If you eat more than you need, you will eventually become fat — not stronger! Fatness is a kind of illness. For being healthy and strong, therefore, you must eat the right amount of food, containing the right amount of essential nutrients. Scientists have now found out by doing experiments what kind and what amount of food will give you the right amount of essential nutrients. Such food is called **balanced food**. A meal in which you eat balanced food is called a

balanced meal. A group of balanced meals taken during the day is called a **balanced diet.** The information given in Table I will help you in planning a balanced diet. Remember, there can be an unlimited number of balanced diets. One can obtain further information on balanced diets from the National Institute of Nutrition, Hyderabad 500 007, or from one's nearest Community Health Centre. These organisations can also help you in planning balanced diets based on the food-stuffs available in your locality.

3.4 What is in the food we eat?

Materials present in food can be classified in several groups of compounds. The more important of these groups are: **proteins,**

TABLE I

A BALANCED DIET FOR AN 11-12 YEARS OLD

Food-stuffs	Vegetarian		Non-vegetarian	
	Weight	Volume of cooked food	Weight	Volume of cooked food
Cereals	320 g	10 cups	320 g	10 cups
(a) rice	160 g	5 cups	160 g	5 cups
(b) wheat	160 g	6–7 chapatis	160 g	6–7 chapatis
Pulses	70 g	3 cups — thin after cooking	60 g	$2\frac{1}{4}$ cups — thin after cooking
Green leafy vegetables	100 g	2 table spoons (tbsp.)	100 g	2 tbsp.
Other vegetables, roots and tubers	75 g	$\frac{1}{2}$ cup	75 g	$\frac{1}{2}$ cup
Fruits	50 g	$\frac{1}{2}$ fruit	50 g	$\frac{1}{2}$ fruit
Milk	250 g	1 glass	200 g	$\frac{3}{4}$ glass
Fat and oil	35 g	2 tbsp	35 g	2 tbsp
Sugar or jaggery	50 g	3 tbsp	50 g	3 tbsp
Meat, fish or egg	—	—	30 g or 1 egg	

carbohydrates, fats, vitamins, minerals and **water**. Carbohydrates and fats are used by our body mainly for producing energy. Potato, rice, wheat and banana are rich in carbohydrates. Sugar is all carbohydrate. Milk, oil, ghee and peanuts are rich in fats.

Proteins are used mainly for building new body material required for growth, for replacement of wornout or dead parts and for the repair of damaged parts. Meat, fish, egg, milk and all pulses (*dal*) are rich in proteins.

Vitamins and minerals perform specific jobs in the body. For example, vitamins help in keeping our eyes, bones, teeth and gums healthy. Without the vitamins, many chemical reactions in our body will not occur. Minerals help in the formation of blood, bones and teeth and in many other ways. Fruits, vegetables, milk meat, eggs, fish liver oil and hand-polished rice are good sources of vitamins and minerals. Since none of the foodstuffs contains all the vitamins and minerals we need, we should eat a suitable combination of them.

Water is the essence of life! Without it, we would not be able to use most of the other food materials. We can live longer without food than without water!

Carbohydrates, fats, proteins and vitamins are found in nature only in living organisms. That is why almost all our food comes from living organisms.

We cannot do without any of the above major compounds. The amount one will need of each of these groups will, however, depend on one's special needs. A person who does a lot of physical work everyday needs more carbohydrates and fats. A young person who is still growing needs to eat food rich in proteins. A person who is sick often needs a special kind of food. For example, in some diseases the doctor advises us to eat less carbohydrates (as in diabetes) or less salt (as in high blood pressure).

Once all the needs we have mentioned above are satisfied, food can be **as varied as possible**. It is not right to say that another person's food is worse than ours, unless we can show that his food does not satisfy these needs as well as ours does.

The essential nutrients are:

(i) Certain amino-acids (amino-acids are a **group** of compounds);

(ii) Certain fatty acids (fatty acids are another group of compounds);

(iii) Vitamins;

(iv) Certain minerals.

We take amino-acids in the form of protein, and fatty acids in the form of

fats. Most of the vitamins and all minerals exist in our food in a ready-made form.

3.5 Food for plants

Food for animals comes from plants and from other animals. Where does the food for a plant come from? Plants alone have the marvellous ability to take raw materials from nature and 'cook' their food **within themselves**. Plants can take water, salts and other minerals from the soil, and carbon dioxide from the air. From these materials they can make — in their own body — carbohydrates, proteins, fats, vitamins and all the other compounds they need. The fuel for this "cooking" is sunlight! Man cannot use sunlight to run a food factory inside him!

3.6 Bacteria spoil food

You know that many types of food, raw or cooked, get spoiled easily. Bread kept for a few days in a warm, humid place usually has mould growing on it. *Samosas*, kept for two days in the open, taste strange and spoiled. These events happen because of the action of bacteria and other minute organisms on food. Such action makes the food poisonous and unfit for eating. You can easily learn to find out whether food is spoiled — by looking at it, smelling it, and tasting **very little** of it. If you suspect that a food item is spoiled, do not eat it. It may cause you a great deal of harm!

How can we prevent food from spoiling? We know that bacteria spoil food. We can prevent bacteria from reaching the food, or we can kill the bacteria.

Food kept in closed containers will generally last longer than food kept in the open. Can you say why? Bacteria present in the atmosphere will reach the open food more easily.

Sometimes, we heat the food to preserve it, as heating kills many bacteria. For example, we boil milk to prevent it from spoiling. Many items of food can be preserved by simply drying in the sun.

Bacteria multiply (that is, produce more bacteria of their kind) less at cooler temperature. Therefore, food kept in the cold — as in a refrigerator — lasts longer. We use this knowledge in modern dairies where milk is first heated, then cooled very fast and stored in the cold. Fish and meat are transported to far off places in special trucks and boats in which they can be kept cold. Food preserved in the cold can be kept for very long — sometimes months and

years. Food preserved in this way is just as nutritious and often just as tasty as fresh food is. For most foods, the lower the temperature of storage, the larger is the period for which the food can be preserved.

Some kinds of food spoil easily. Some last long. We often convert food items that are easily spoiled into items that would last long. For example, milk which cannot be kept at room temperature for too long is often converted into butter and ghee, which can be stored for months. Fruits and vegetables that spoil easily can be stored for years after conversion into jams, jellies and pickle. The **salt** and the spices in the pickle or the large amount of sugar in the jam or the jelly prevents the bacteria from spoiling the vegetables or the fruits.

Sometimes metals, such as lead or tin, get into our food and make it poisonous.

There are, however, some bacteria that 'spoil' food, but in the process make it quite 'useful'. Funny, isn't it? Yes, but remember milk is converted into curd by bacteria. Since we **like** curd, we do not say that milk is 'spoiled' into curd. Examples like this are, however, rare. Generally, food spoiled by bacteria is not good for health and should not be eaten. It can even kill a person.

3.7 Some species are specially clever

Most of the living species will die if they are not given food. Several living species, however, have developed a **mechanism** to hold themselves in a state of **suspended life** for a long period without food. A seed of a plant is such a living object in a state of suspended life. Remember, you have seen that a seed does not grow until water and air are given to it. Some animals, like frogs, snakes, bears and beavers (beavers are small mammals found in North America), can also stay for many months in a state of suspended life; in the case of animals, this process of going into a state of suspended life when conditions are unfavourable (for example, when it is very cold) is called **hibernation**. Many bacteria and fungi change their shape, size and appearance and go in a state of suspended life, called **spores**, when no food is available. Spores, like seeds, can live for very, very long time without food. Some spores have been known to live for thousands of years.

4. ACTIVITIES

4.1 List all the uncooked items of food that you are familiar with. Indicate the importance of each of these items in our diet. In other words, what needs of man are met by these items when they are cooked and eaten? For example, potato is useful because it is a good source of carbohydrates. Spinach gives us compounds of iron and of calcium, which are important minerals for us.

4.2 Prepare a chart showing the food you have eaten during one week (Monday to Sunday). Try to find out if any essential nutrient was missing from your diet during the week.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 The food: the need and the variety

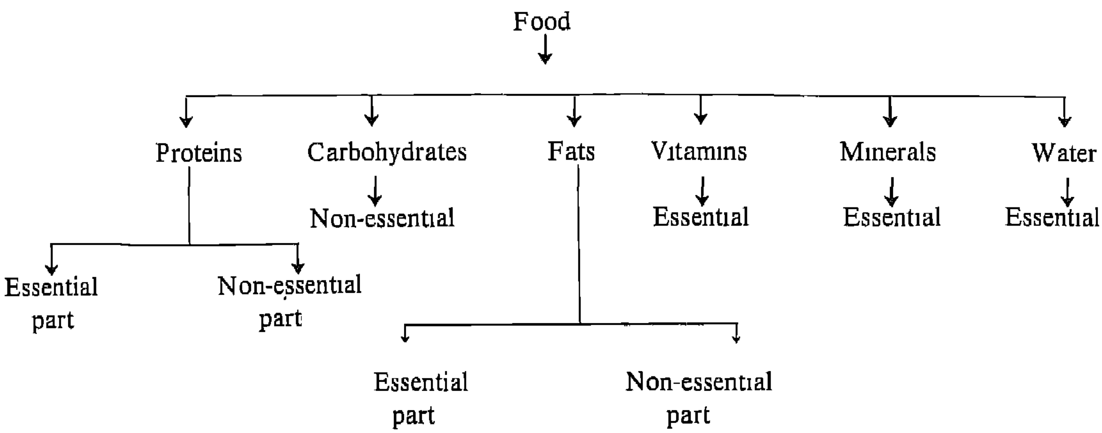
We have learnt that all living objects need food for growth, for maintenance, for repairing damage and wear and tear, and for generating the energy they need. The food and the eating habits vary enormously from species to species. In the case of man, the nature of food eaten also varies enormously. People in different parts of the world, or in different parts of the same country, use different materials as food. Even where the same material is used, it is often cooked differently. There are probably scores of ways of cooking potatoes, rice or eggs. Try to name as many as you can and then add to your list by asking your friends.

5.2 What is in the food we eat?

The food we eat consists of several groups of materials: proteins, carbohydrates, fats, vitamins, minerals and water. All of these groups are necessary for man, although the proportion and amount of each that needs to be taken, vary from individual to individual. Children need food rich in protein in order to grow healthy. People who work hard with their hands need food rich in carbohydrates and fats.

Our body is made of a very large number of different compounds. Many of these compounds, even if not present in food, can be made from **other** compounds present in food. There is, however, a small number of

compounds without which we cannot live and which cannot be made from other substances present in food. These compounds, therefore, have to be present in our food in a ready-made form. Such compounds are called essential nutrients. We have learnt something about these nutrients. Each of these nutrients is a part of one of the **groups** of materials present in food, shown below.



We must remember that when we say a compound is an essential nutrient, we only mean that it cannot be made by the body and has to be supplied "ready-made". To be healthy and active, one should also eat the other items that we have listed as non-essential, such as carbohydrates. Carbohydrates **can** be made in the human body from other substances, such as fats and proteins. They are, however, not generally made in this way in quantities required by the body to perform its normal functions.

5.3 What should we eat?

We have learnt that for us to be healthy, our daily diet must be balanced. A balanced diet is a diet which contains just enough (neither less nor more) of the essential nutrients, and which provides enough of the various groups of nutrients to take care of the particular needs of a person. You will no doubt want to know how much is enough. Our scientists have analysed a very large number of food items eaten commonly in different parts of our country. They have found out the amount of each nutrient contained in them. This information allows us to prepare balanced diets which tell us exactly how much of each food item we should

eat. One such balanced diet for 11-12 years old is given in Table 1. We should remember that expensive meals are not always balanced and cheap ones not always unbalanced.

5.4 Food fads

You must have heard many statements about food such as: "Eating onions is bad for the heart", or "eating *bhindi* (lady's finger) or fishes makes you good in mathematics", or "eat a lot of *ghee*; it will make you healthy". Are they really true? We now know, from scientific study, that these statements are not correct. Such incorrect and unscientific ideas about food are called food fads. Unfortunately, a large number of people in our country as well as in other countries believe in some food fad or the other. How did the food fads come about? There seem to be four main reasons for them.

(a) It is only recently (in the past 50 years or so) that we have come to know about essential nutrients and balanced diets. Very little of this information was available when your grandfather was born! Lack of knowledge often led to incorrect belief. May be, a very good mathematician once liked a lot of *bhindi* or fish, and people therefore began to think that if they also ate *bhindi*, they, too, would be good in mathematics! Such beliefs held in the past have unfortunately continued even today.

(b) Nowadays, a large variety of food items are available in many towns and cities. For example, just 30 years ago, you could not buy a *dosa* in Kanpur! Similarly, a *samosa* could not be obtained in Madurai 30 years ago! Even today, many people in North India have not heard of *pongal* or *uppumah*, which are so common in the South! Have you heard of oregano? Probably not, but in Italy, they cannot do without it! Of caviar? Every Russian knows what it is! Ask an American what *parwal*, or *pan* or *shareefa* is, and he would wonder if it is a person or a place!

When a new food item comes to a place, people are at first cautious — even nervous — about eating it. When cauliflower was first brought to India, people were very reluctant to eat it. People probably invented reasons for not eating it! Many food fads are just such inventions. "Eating onion is bad for health", is a food fad. Some nervous person could have invented this food fad when he first saw an onion and did not want others to know that he was afraid of eating it!

(c) People often believe that if a food item is expensive, it must be very

good for health! This is generally not true. Many of us think that eating grapes is very good for health. Is this not just because grapes are often expensive? Actually, grapes have very little food value. Again, many people believe that pure *ghee* is far superior to vegetable oils. Is this not because *ghee* is far more expensive than oil? Actually, eating too much ghee can do more harm than good. Vegetable oils on the other hand, do not cause any harm. They are also cheaper and more easily available. Many food fads are, therefore, 'status symbols'! They are often started by the rich.

(**d**) Sometimes, food fads arise out of custom and tradition. There are people in India who will not eat meat, fish or eggs. These people are called vegetarians. In our country, many persons (about 30 out of every 100) are vegetarians — largely because of custom and tradition. Some vegetarians, however, think that their food and diet is superior to meat or fish. This is a food fad. In practice, it is much easier to balance a non-vegetarian than a vegetarian diet. In fact, neither vegetarianism nor non-vegetarianism is bad, as long as one eats a balanced diet.

Make a list of food fads you know. Why do you think that they are fads?

5.5 Our responsibility

In our country, people do not have enough food to eat. Even if food is available, they do not have money to buy enough of it. That is why we have a large number of people suffering from diseases which are a result of their not eating enough. The country's "food problem" is becoming greater every year due to an increase in our population. Can we help solve this problem? Here are some ways in which we **can** help:

(**a**) We should grow more food. To do this, we should work harder on our farms, and use better seeds and sufficient fertilizers.

(**b**) The food that we produce should not get spoilt or eaten away by animals. In our country, at present, a large amount of food is eaten away by rats, insects, birds, and stray cattle.

(**c**) The foodgrains that we grow should be inexpensive and of good nutritive value.

(**d**) Each one of us should make sure not to overeat or waste food.

(**e**) We should try to change our food habits, such that (**i**) we all get enough of the right kind of food, and (**ii**) we all use food that is easily and cheaply available in the region.

(**f**) We should do our best to see that the population of the country does

not increase.

5.6 We are lucky!

If you observe carefully, you will find that animals other than man spend most of their working time searching for food. In the very early days, man also did the same. But today he does many other things besides looking for food. This is because he has learnt to farm. A small number of people can today produce food for a large number. Many, therefore, have time to do other things.

CHAPTER 11

MAN'S DEPENDENCE ON PLANTS AND ANIMALS AND THE BALANCE IN NATURE

1. OBSERVATIONS

1.1 We see a number of plants and animals around us. We see them in our house, on the farm, in the field, in the forest, in the garden, on the tree and in the air.

1.2 Some plants and animals are cultivated or bred by man for special purposes. Wheat, rice, cow and dog are a few examples. Other plants and animals seem to grow **wild** — that is, without being taken care of by man.

1.3 Out of the plants and animals which seem to grow wild, many are closely associated with man — whether he likes them or not (**P**1)! Examples are:

Cockroaches, ants, houseflies, lizards and rats in the house.

Sparrows and weeds in the garden.

Crows in the village or city.

1.4 There are also other plants and animals which grow wild and are a great nuisance to man. Some examples are:

Water hyacinth.

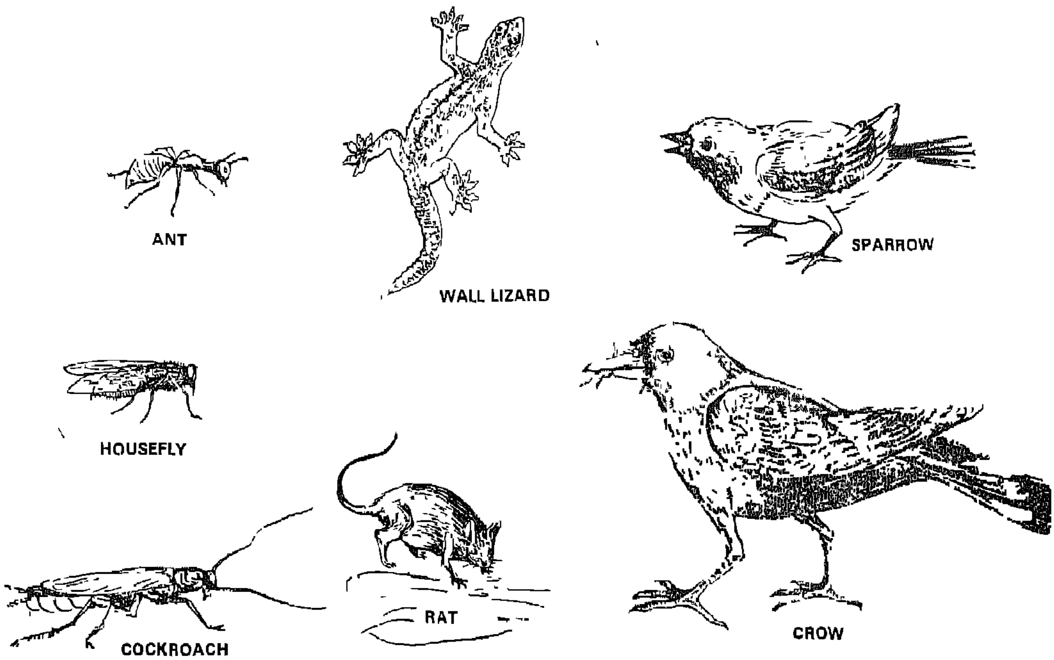
Carrot grass (the *Parthenium* weed), which came into the country only a few years ago, but has now spread to many parts of the country, such as Maharashtra, Delhi and Tamil Nadu.

Bats, which destroy fruits in the orchards.

Insects, which destroy plants.

Can you think of other examples?

1.5 We observe that all living objects die sooner or later. We saw in Chapter 8 that each living species has an average life-span. Our average life-span is about 60 years; no man is known to live for, say, 200 years. A mouse generally lives for about 2 years. No man or mouse — or any



PICTURE 1

living object — can be **immortal.**

1.6 Just as we see living organisms die, we also know that new ones are being born all the time.

2. QUESTIONS

2.1 We see that certain plants and animals are of direct use to us today. Can we live without plants and animals?

2.2 What about animals which do not seem to be of any use to us? Should we try to get rid of them completely?

2.3 What are **all** the uses of plants and animals? We have studied some uses earlier. Are there any other?

2.4 We have observed that some plants, animals and man live in close association with each other. Do living species **generally** depend on each other, or does it happen only in a few cases?

2.5 Do living organisms also depend on non-living substances?

2.6 What happens to dead animals and plants? What will happen if none of them ever died?

3. LET US FIND OUT

3.1 Plants and animals as food

All the food we generally eat comes from plants and animals.

(a) Examples of animals which are commonly used as food today in various parts of the world are:

Fish	Sheep
Crabs	Prawn
Oysters	Camels
Lobsters	Chicken
Turtles	Turkeys
Pigeons	Ducks
Deer	

(b) Some **products** obtained from animals are also widely used as food; examples are:

Milk	Lard
Eggs of hens and ducks	Gelatin
Eggs of certain fish (caviar)	Honey

Try to find out how these products are obtained.

(c) Examples of plants which are eaten as whole (or almost as whole) are:

Lettuce	Coriander
Spinach	Radish
Mustard	*Podina*
Rye	

(d) Examples of plants, of which only certain parts are eaten, are:

Wheat	Maize
Rice	Pulses
Mango	Potato
Onion	Guava

For your interest we have given a much larger list of such plants at the end of the book (See **Interesting Information**, Set 2).

All the food that any animal eats comes directly or indirectly from plants. Let us take an example. We may eat sheep, goat, deer etc. What do they eat? Plant materials.

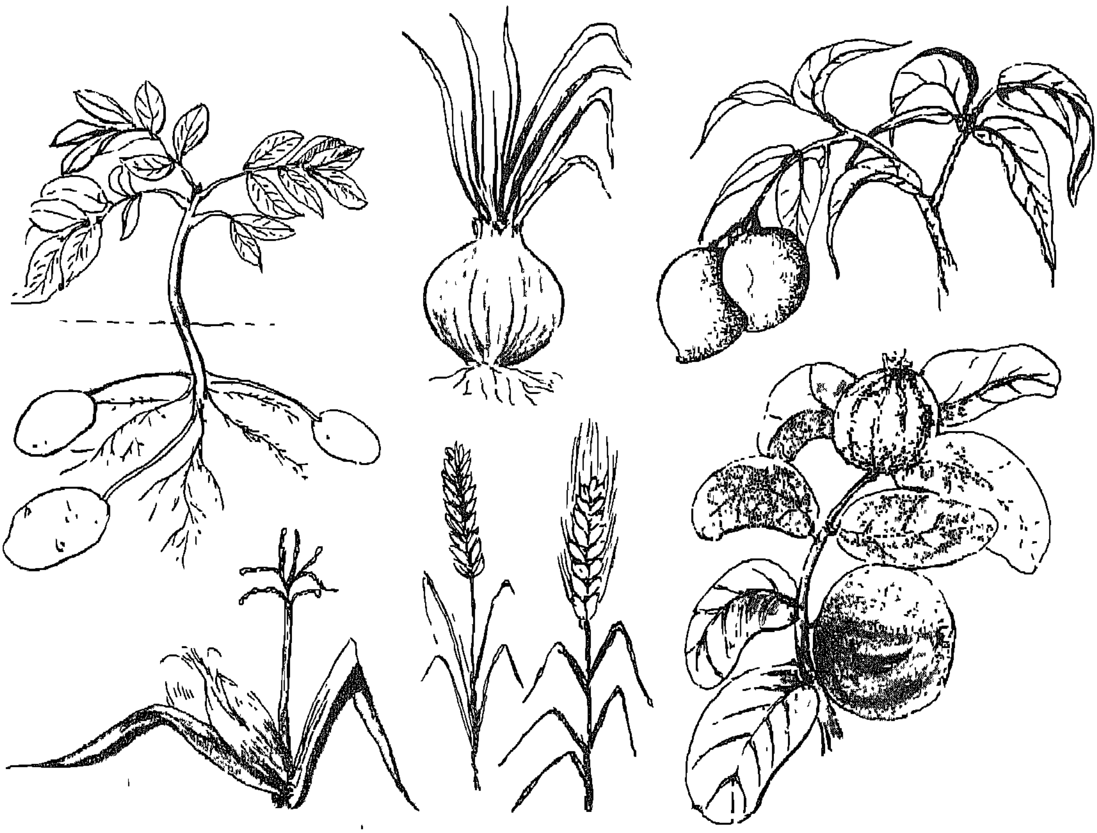
3.2 Other uses of plants

Plants are useful for man not only as food but also in many other ways. Some other uses of plants are given in Table 1 at the end of this chapter.

Many bacteria and fungi are used by man to produce important compounds and food-stuffs. The fungus, yeast, is used in factories to produce alcohol, a very important compound for industry. Yeast is also used to make bread. Many fungi are used to produce medicines, such as penicillin. Citric acid, which makes the bottled drinks taste sour, is produced all over the world by a special fungus. The curd we eat is a result of the action of certain bacteria on milk. Decomposition of living objects after death is carried out in nature, primarily by bacteria.

3.3 Other uses of animals

Animals not only serve as a source



PICTURE 2

of food for man, but they also help man in many other ways:

Birds and insects help carry seeds from one place to another.

Birds and insects also help carry plant pollen grains from one plant to the ovaries of another. If this did not happen in nature, many plants would not reproduce. Remember, plants cannot move by themselves from one place to another!

Fish help keep water clean by eating other organisms living in water.

The skin of cattle (cow, goat and sheep) is used for producing leather.

Bones of many animals, such as cow, goat and sheep, are used for making gelatin. Gelatin is used as a food-stuff.

Bones are also used to make certain types of fertilizer.

Horns of many animals are used for decoration.

Many animals are used to carry loads and to pull vehicles and ploughs

Bees produce honey and wax.

Silkworms produce silk which used to make clothes. Silk clothes a

strong and lasting.

Lac insects produce **shellac**, which is used in the preparation of paints and varnishes and as sealing wax.

Pigeons are used to carry messages over long distances.

Dog is useful to man in various ways. It has a keen sense of smell, tremendous loyalty and attachment to its master, agility and long memory. Here are some ways in which the dog serves man:

(i) it can lead a blind man
(ii) it protects our homes and farms
(iii) it can be trained to trace a smell; police use trained dogs to trace criminals
(iv) it helps hunters by recovering hunted animals
(v) it protects herds from wild animals
(vi) in cold countries, it even pulls carts, called sledges, over snow.

3.4 Plants are indispensable

You would have realized that it would be impossible for man to live without plants and animals. Most plants can survive without animals but animals cannot survive without plants. Recall that plants can obtain **all** their food from air, water and soil with the help of sunlight. Food for all the animals, including man, comes ultimately from plants.

3.5 Dependence of other species on each other

Just as man depends on other living species, other species also depend on each other. Let us look at some examples.

All vegetarian animals (like the cow, the goat, the deer, the elephant, the rhinoceros and the grass hopper) live directly on plants.

There are many animals, such as the lion, the tiger, the leopard and the frog, which are 'non-vegetarian'. They do not eat plants, or food made from plants. Such animals live on other animals.

Many fish live on other fish. For example, the shark lives on smaller fishes.

Spiders and the house lizards live on insects (you can see this for yourself if you look around carefully).

There are insects which eat other insects.

Some plants, like *Drosera*, live on insects.

Leeches and mosquitoes live on the blood of other animals.

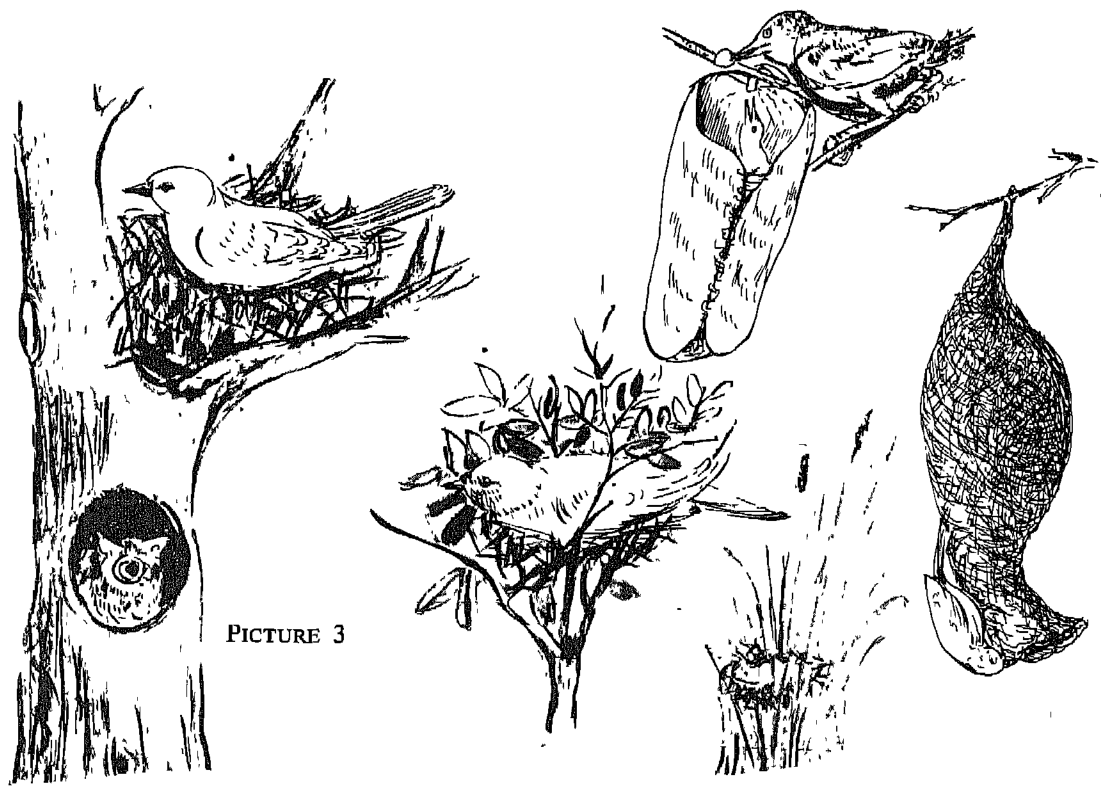
Some plants, such as dodder, seem to be lazy and reluctant to prepare their own food. They simply lodge themselves on other, larger plants and

draw their food from them. If you look at the trees around you, you may find such **parasites** growing on them. Such parasites cannot grow without a **host**.

Many animals and bacteria also live as parasites on other living organisms. Such parasites are usually harmful. For example, certain protozoa often live as parasites inside our intestines. One such parasite called *Entamoeba* causes the disease amoebic dysentery.

Many birds (like parakeets, owls, crows and vultures) and bats depend on shrubs and trees for shelter. You will find it interesting to look at the nests of birds in the trees and shrubs around you. Such nests are extremely common.

Many living species live in association with each other and help each other. For example, the green hydra lives in association with the alga *Zoochlorella*; each one supplies the other with some prepared food. Lichen, which you may find on tree trunks, is the name given to a combination of a fungus and an alga living so closely together that they look like one organism. A very important case is that of certain bacteria (*Rhizobium*, for example) which live in association with the roots of certain plants, such as pulses. These bacteria convert atmospheric nitrogen into food that can be easily used by the plant. If only we could persuade *Rhizobium* to give similar help to all the other plants



PICTURE 3

in the world, we would need very little fertilizer! Most fertilizers give to other plants just what *Rhizobium* gives to the plants it likes to associate with.

3.6 The food chain and the balance in nature

We should now be able to see that there exist in nature many food chains. Two examples are given below (**P**4):

Secretary birds (found in Africa) eat snakes	Large fish (like shark) eat small fish
↓	↓
Snakes eat frogs	Small fish eat small shrimps
↓	↓
Frogs eat insects	Small shrimps eat **plants**
↓	
Insects eat **plants**	

PICTURE 4

Let us now construct the food chain for man.

Man eats

↓

Large fish	Ducks	Chicken	Plants
↓	↓	↓	
Large fish eat small fish	Ducks eat mussels	Chicken eat grains (of **plants**)	
↓	↓		
Small fish eat small shrimps	Mussels eat **plants**		
↓			
Small shrimps eat **plants**			

You can construct more of such food chains. You will notice that all food chains **begin** with plants.

An interesting thing about man is that he can eat lots of things that are **eaten by the objects that he eats.** He is in fact the most **versatile** animal as far as food is concerned. He, therefore, competes with a very large number of living species for food: with insects for plants, with rat for grain, with lions and tigers for meat, with large fish for small fish and shrimps, and so on.

3.7 The balance in nature

You have seen that living species are interdependent and one species often serves as food or shelter for another. Why then do the secretary birds not eat up **all** the snakes, or the large fish eat up **all** the small fish? The fact is that the snakes or the small fish are not always **waiting** to be eaten! They do their best to save themselves. Remember, a deer runs for its life when it sees a lion, and often escapes! If the secretary birds did eat up all the snakes around, soon there would be no food left for them to eat. With no more food, the secretary bird population will die out. It is, therefore, important that a certain balance be maintained between species.

As we have already seen, the survival of man depends on a large number of species, which, in turn, depend on a large number of other species. It is, therefore, important for man to make sure that a proper balance of living species is maintained in nature. Unfortunately, man has not been as careful in maintaining this balance as he should have been. For example, he has been careless in using substances that kill insects. These substances are also harmful to birds. They have, therefore, destroyed many useful birds as well along with the harmful insects in several parts of the world. We may not like frogs, but killing too many of them can result in increasing the number of insects which destroy the food crops: frogs eat insects and keep their number down. Similarly, felling of trees can cut down rainfall, make the soil less fertile and, finally, lead to less food for the people.

Unfortunately, we do not yet know everything about all the food chains that may exist in nature. We cannot, therefore, say with certainty that nothing will happen to man if a species becomes extinct or is reduced in number. It would be unwise to do anything today, which may lead to the extinction of a species. Once a species becomes extinct, we **cannot** have it back! Therefore, as far as possible we should try to prevent any species from becoming extinct. Even snakes, which are apparently harmful, eat rats which destroy crops! Every species probably plays a part in maintaining the balance in nature.

We have learnt that the balance in nature – that is, the balance between the population of each species – is dependent on each species playin several opposing roles: of **prey** an **predator**, of **companion** and **com petitor**, of **scavanger** and **parasite**, and so on.

The balance in nature also depends

on two other interesting and important factors:

(a) All living objects die. What happens to them after they die? Some of them are, of course, eaten up by animals, such as vultures, crows, hyena and some insects. The rest of them are broken down by bacteria. During this process, a part of the material of which the living object was made is returned to the soil or water and the remaining part to the air. The material returned in this way to nature is free to be used again by living organisms as food. We, therefore, have another cycle here.

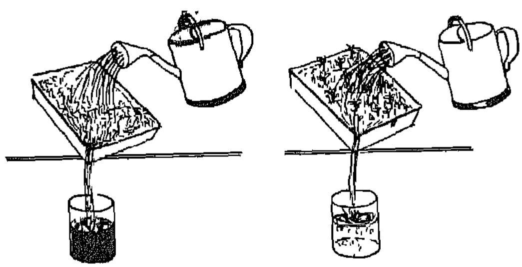
(b) Living organisms depend not only on other living organisms, but also very much on the environment: temperature, sunlight, rainfall, soil, water and air. You will recall that plants can affect rainfall and, consequently, temperature and soil. Therefore, there exists a cycle here too: Plants affect the environment and the environment affects the plants.

4. ACTIVITIES

4.1 Make a list of all the things in your home which have come from plants or animals.

4.2 Study the map of India. Find out where the fertile regions are located. Do these regions have more or less rainfall than the regions that are not fertile?

4.3 Take two trays and fill them with soil. In one tray sow some grass. Keep the other tray without any plant. After the grass has grown a few inches (this will take a few days), put the trays in an inclined position and pour water with a can on the top of the trays. Collect separately the water that overflows from the bottom of the two trays. You will see that the water in one of the trays is clearer than the other. Can you give the reason? Do you now understand how plants protect the soil and prevent erosion?



PICTURE 5

4.4 Estimate the number of persons in your village or locality. Then estimate the population of any other living species (any type of plant or animal) in your locality and calculate the number

of individuals of this living species **per human being** in your locality. Compare the value obtained with that obtained by your classmates. For example, there may be 200 persons in your locality and 300 rose bushes. The number of rose bushes per person in your locality would be 300/200 = 1.5 (If this is so, consider yourself very lucky!)

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Living forms depend on each other

The most important thing we have learnt in this chapter is that all living forms depend on other living forms. Man is entirely dependent on plants and on other animals. He derives all his food from plants and animals, and he makes use of them in many ways.

5.2 Balance in nature

Another important fact that we have learnt is that there exists a balance in nature. Man can harm himself by disturbing this balance too much. Man may disturb this balance in nature by careless killing of species and by polluting the environment.

Balance of nature has not always been the same. The relationship between species has also changed. For example, there was a time when man did not know how to cultivate plants; he, at that time lived entirely on natural fruits and animals. He gradually learnt to cultivate plants and domesticate animals. Many species can now live only under human protection, unlike the "wild" species. Man gets a lot more from the domesticated species than he does from the wild species. Therefore, he should take special care of domesticated species of plants and animals.

Natural balances are different in different areas of the world, because the plant and animal life is different in different areas. Yet there is much interaction between different regions of the world. For example, as we have already seen, a large number of birds come to the Bharatpur bird sanctuary in Rajasthan from Siberia every winter. The birds stay in India for a few months and then return to Siberia. These birds are a part of the balance of nature in **both** the countries — India and the U.S.S.R.

TABLE 1

SOME USES OF PLANTS

Use (1)	*Plants* (2)	*Parts used* (3)	*Special features* (4)
As firewood or for producing charcoal	*Sundari*	Stem	Has a red-coloured stem Found in Sundarban area
For producing wood for furniture and for other similar uses	Teak	Stem	Grows in Madhya Pradesh and Tarai regions. Very hard.
	Sal	Stem	Many varieties. Very hard.
	Bamboo	Stem	Long, thin and durable. Also used for building and for covering objects.
	Cane	Stem	
	Coconut	Leaves	Also used for covering roof-tops and for making broomsticks
For use as a medicine directly, or for producing medicines	*Neem*	Stem and leaf	Also used for cleaning teeth.
	Rauwolfia	Leaf	Used for the treatment of high blood pressure.
	Cinchona	Bark	Used for preparing quinine to treat malaria.
	Eucalyptus	Oil from the stem	Used for relieving cold.
For producing paper	Bamboo and certain other grasses	Stem and leaf	
For making useful fibres such as cotton and jute	Cotton	Fruit	The fibres are used for preparing threads from which cloth can be made.
	Jute	Stem	The fibres are used for making gunny-bags.

	Mesta	Stem	The fibres are used for making various types of ropes and gunny-bags.
	Coconut	Fruit	The fibres (known as coir) are used for making ropes, mats and rugs.
For making gums and resins	Pine	Stem	The gum or the resin is secreted from the stem.
	Acacia	Stem	
	Sirish	Stem	
	Rubber	Stem	
For decoration	*Devdaru* and *Ashoka*	Entire tree	Used as decorative trees in gardens and for avenues and boulevards.
	Juniper	Leaves	Used for interior decoration.
	Rose and tube rose	Flowers	Used for interior decoration.
	Jasmine	Flowers	Used for personal adornment.
	Cactus	Various parts	Used for interior decoration.
	Money plant	Entire plant	Used for interior decoration.
	Crotons	Entire plant	Used as decorative plants in the garden; leaves often used for interior decoration
For conservation of water and soil	Grass	Entire plant	
	Railway creeper	Entire plant	

For providing shade	*Banyan* *Peepal* *Neem* *Gulmohar*	Entire tree	These are among the most common trees in our country
For making soil rich in nutrients, which the other plants can use	Pulses	Roots	A bacterium called *Rhizobium* lives with the roots and enables the plant to use atmospheric nitrogen as food. Pulses, unlike most other plants, do not therefore require much fertiliser
	Weeds	Entire plant	These plants are either burnt on the soil or ploughed **with** the soil where they ultimately become natural manure.
For cleaning up the atmosphere	All trees, especially eucalyptus, *neem* and other tall trees which can provide a large leaf surface	Entire tree	Leaves utilise the carbon dioxide given off by man as a waste product, and convert it to oxygen which is useful for man.
For providing materials from which perfumes are made	Jasmine, rose and many other plants with fragrant flowers	Oil from flowers	
	Lemon grass and other similar grasses	Oil from various parts	

ADAPTABILITY TO THE ENVIRONMENT

1. OBSERVATIONS

1.1 We often see that fair persons become dark when they stay outside in the sun for long. The parts of the body which are exposed to the sun become darker in comparison to the parts that are not exposed (**P**1).

PICTURE 1

1.2 The outside temperature at all places in our country generally varies quite a lot during the day and during the year, but our body temperature stays constant at about 37°C all through the year.

1.3 Most of us feel sleepy at night, but those who work on night shifts in factories are able to keep awake during the night.

1.4 We often get 'adjusted' to a new place, new climate, a new type of food, new people and a new kind of life.

1.5 Can you give other examples of situations where human beings (or individuals of any other living species) are able to adapt themselves to a change in the environment?

2. QUESTION

Why and how do man and other living species adapt themselves to a change in the environment?

3. LET US FIND OUT

The environment in which man and other living species live today is constantly changing. The seasons change during the year: that is, the temperature, the **humidity** (the amount of moisture in the air), the length of the day or the night, the kind of food available, and many other features of the environment, change. The introduction of new materials – wastes from a factory, use of new substances, the spread of an infectious disease—changes our environment.

Therefore, to survive all living organisms must make an effort to adjust themselves to new conditions. If we cannot get adjusted to a new condition such as eating food of a different type, we may be very uncomfortable when we move to a new place.

When living organisms sense a change in the environment, they are usually able to make **adjustments** that help them to cope with the environment. Indeed, if they did not have the ability to make these adjustments, they would face many problems. Let us take some examples of such adjustments.

(**a**) If fair persons did not have the capacity to become dark on exposure to strong light, they would get **burnt** by the light. Sunlight can cause severe burns on the skin! The dark pigment in our skins absorbs the light and prevents it from damaging the parts of the body that are inside. As the amount of sunlight falling on an exposed part of our body increases (as happens in the summer), the amount of the above pigment also increases. That is why the exposed skin becomes darker if we stay in bright sunlight for too long.

(b) The speed at which various chemical changes go on inside our body depends upon the temperature. It is, therefore, important that the temperature of our body does not change from 37°C, which is just right for our body. Our body has many ways of making sure that its temperature remains constant. When it is hot outside, we perspire. When the perspiration evaporates, it causes cooling. When it is cold outside, we shiver; shivering is merely a result of our muscles working harder to produce more heat.

(**c**) Our body is being constantly invaded by foreign substances, both non-living and living, such as medicines, bacteria and **viruses**. (Viruses are very small particles — much smaller than bacteria — that are on the border line of living and non-living. In other words, they can be considered

as both non-living and living, depending on where they are. Many viruses cause diseases in plants and animals.) Many of these foreign substances, if left to themselves in our body, will do a great deal of harm to our body. Our body, therefore, has learnt to recognise them as 'enemy' and deals with them accordingly! It uses several weapons to fight the enemy. One of these weapons is a set of special compounds, called **antibodies**, produced in our body. They go out as soldiers in our blood, surround the enemy there and kill it. If our bodies were a city, our blood would represent the roads and streets of the city. Antibodies are produced in the quantity needed to fight the enemy, and **only** when the enemy enters the body! For each type of enemy, our body produces a different kind of soldier — the antibody — to fight the battle. Is this not a remarkable example of man's ability to cope with the environment?

Sometimes, the enemy invades our body in great strength: there are just too many in the enemy party to be taken care of by our antibodies. We are then defeated by the enemy and suffer from a disease.

Antibodies are formed against most enemies, but not all. They are usually not formed when the enemy is too small: very much smaller than even a virus. To take care of such small enemies, the body produces another class of substances (**enzymes**) which simply act like an axe and chop down the enemy into bits!

All antibodies and enzymes are proteins. Here is yet another way in which our body uses proteins.

Many other animals in nature also use these two methods of defence to prevent diseases.

(**d**) Many processes in our body — as in most living species — occur **rhythmically**, that is, periodically. Some rhythms are fast. For example, the heart beat. Some other rhythms are slow. For example, the cycle of sleep and wakefulness which repeats every 24 hours. Many of these rhythms change as the outside conditions change. For example, our heart beat increases when we run or do excercise. When we do so, we use more energy; to produce more energy, we need more oxygen. Oxygen is supplied to different parts of our body by our blood. Therefore, blood must be carried faster to take more oxygen to the various parts of our body when we run or do excercise, so that they may produce the extra energy needed. That is why the heart beats faster when we run or excercise. The body obviously

has a way of sensing when it needs more oxygen.

Similarly, our body adopts a new daily cycle when we change our sleeping hours. If it did not do so, it would have been very uncomfortable for man to work on night shifts.

4. ACTIVITIES

4.1 Dip your hand in hot water (make sure that the water is not unbearably hot!). It may feel very hot in the beginning when the hand first touches the water, but not so hot after a while — that is, after the hand has been in hot water for a minute or so. What does this experiment show?

4.2 Observe and make a list of animals which change colour with the environment. How does the ability to change colour help the animal?

4.3 Observe how the palms of your hands become rough within a few days of hard manual work? How does this help you?

4.4 Suppose you were to go and live with a friend in a different part of the country. List all the changes in your habits which you think would help you to cope with the change in your environment. Choose a part of the country as far away as possible from the place you live.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 Adaptability in living species

We have learnt that the individual members of various living species, including man, have a remarkable ability to adapt themselves to changes in the environment. This adaptability is necessary as our environment, even at the same place, keeps on changing all the time.

During the last 50 years, both the needs and the opportunities for people to travel have increased continuously. It has, therefore, become more necessary than ever before for human beings to be able to adapt themselves to a new environment. Can you list some of the changes that may occur in our environment, when we move from one place to another?

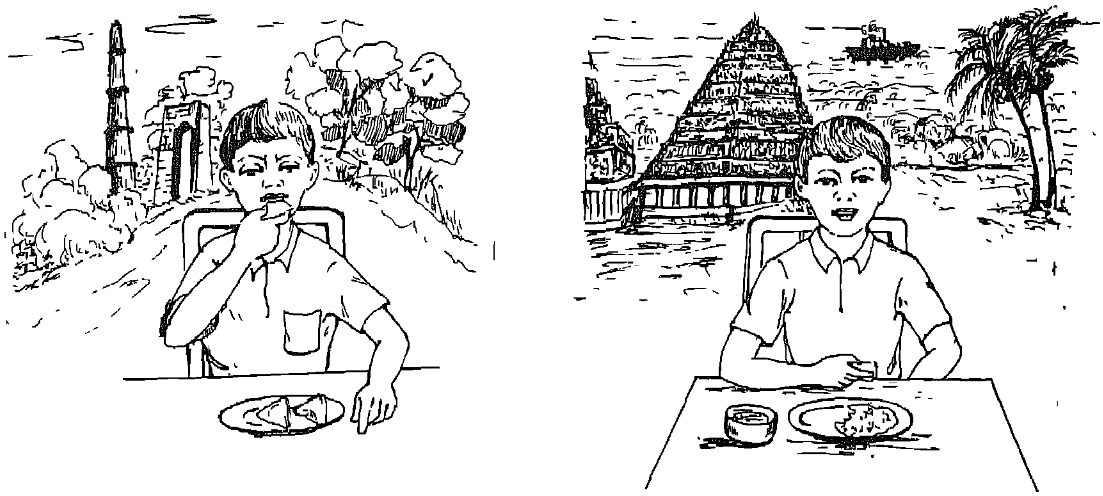
5.2 Some adaptations occur **unconsciously** — that is, without our knowledge. For example, we meet new people; in course of time, they become our friends. The same is true of the

chemical changes that occur in our body rhythmically. The timing of these changes is altered without any conscious effort on our part when we change our habits, for example, the time during which we sleep.

make every effort to like the food. If we do so, we will find that we often do come to like the food!

5.4 The limits

There are limits to which any animal



PICTURE 2

5.3 A Samosa **is as good as a** Dosa

Often, we need to make a **conscious** effort to adapt oursleves to a change in the environment. When we move from one place to another, we may not like the food of the other place (**P2**). This food may not be necessarily bad. From the nutritional point of view it may be as good as, or even better than, our food. We should, in such a situation,

can cope with a change in the environment. Recall what we learnt about the attack on our bodies by foreign substances. Similarly, there is a limit to which our body can adapt to heat or to cold without any other protection. We should always try to know these limits and make sure that we do not cross them; otherwise we may get sick.

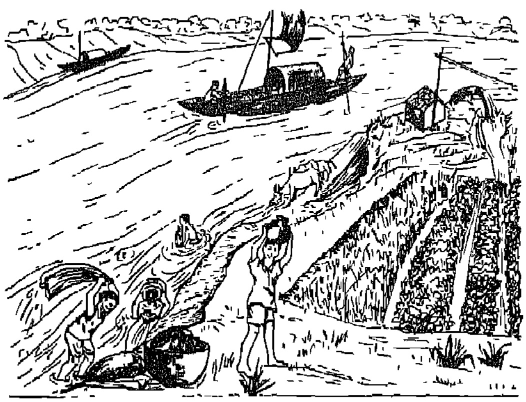
CHAPTER 13

WATER

1. OBSERVATIONS

1.1 We use water (as water, ice or steam) for many purposes (**P**1):

- — for drinking
- — for washing and cleaning
- — for cooling
- — for growing plants
- — for generating electricity
- — for transporting men and goods (on rivers, lakes and seas)
- — for generating power as in steam engines and in water mills
- — for putting out fire



PICTURE 1

Can you add to this list?

1.2 We observe that all organisms use water and depend on water for their life.

1.3 A large number of living organisms live **in** water (**P**2). Can you recall the names of some of these organisms?

PICTURE 2

1.4 Water is a material available in plenty. Two-thirds of the earth's surface is covered with water.

1.5 We obtain water from a large

number of sources: wells, ponds, tanks, lakes, rivers, springs and sea

2. QUESTIONS

2.1 What does water do in living organisms?

2.2 Water keeps on coming to the sources we just mentioned. If it did not keep coming, we would not be able to use these sources for long. Where do these sources — wells, rivers, lakes, ponds, tanks and springs — receive their water from?

2.3 Is all water (the water we obtain from different sources at different places) the same?

2.4 What makes water so useful?

2.5 Can something go wrong with water?

3. LET US FIND OUT

3.1 Water is essential for life

As we have seen, water is an essential part of all living organisms. All of them, without exception, contain water. Living objects are, in fact, mostly water! Blood, through which nutrients (including the oxygen from the air we inhale) are carried to various parts of the body, contains a lot of water. So does saliva which helps us in **digesting** food — that is, converting it into compounds that our body can use.

You know that a large number of chemical reactions go on in living organisms, for example, when we digest food. None of these chemical reactions would be possible without water. Water is thus essential for life. In fact, man is made up of 65% water; a jellyfish is 95% water, and a watermelon is nearly 98% water. There is no living organism on earth that does not have water in it.

3.2 The water cycle

(**a**) The largest source of water on earth is the sea. Water from the sea evaporates due to the heat of the sun. The water vapour so formed becomes a part of air. The water vapour, or **moisture** as we call it, often settles around fine dust particles in the air and gives a water drop. A large collection of water drops becomes a cloud. The water drops in the cloud gradually increase in size till they become too heavy for the cloud. They then fall down on earth, and we have **rain**. The

rain comes down not only on the sea but also on the land. How on the land? The air currents carry some of the clouds to land and then across the land. And how are air currents formed? When a portion of earth's surface becomes slightly hotter than the adjoining area, the air above this portion also becomes comparatively warmer. The warm air being lighter, rises up in the atmosphere. The colder air — which is heavier — from the adjoining area, comes down to take up the space released by the rising hot air. This movement of air gives rise to an air current. An air current is called by different names such as breeze, wind and hurricane, depending on its speed. Air currents are, therefore, a result of the uneven heating of different parts of the earth's surface.

(**b**) What happens to the rain water?

(i) Some water evaporates and goes back to the atmosphere.

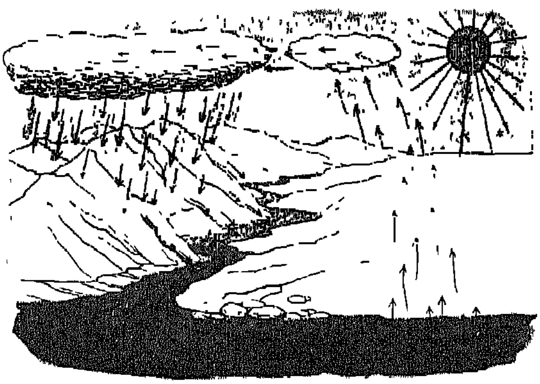
(ii) Some water soaks and penetrates (**percolates**) into the ground, making the soil moist. As more rain falls, the percolated water moves down the soil until it meets a hard rock. We call this water **groundwater**. It collects **underground** and begins to move towards an opening in the ground. When it finds an opening, it comes out, and is called a **spring**. Springs feed wells, lakes and some rivers.

Often, the bottom of the well or the lake slowly gets filled with mud: the opening of the spring then gets blocked. Removing these blocks is necessary if we want a constant supply of fresh water into the well or the lake.

(**iii**) A part of the rain water forms small water currents which move from higher to lower places. Often, many such currents join one another to give a large current called a **river**. The river then begins to flow towards low-lying land. While the river is flowing, some of its water evaporates and some percolates into the ground, but a considerable portion flows on. The flow of the river generally continues until the river meets the sea. In fact, there is only one important river on our earth which does not end up in the sea! It is River Jordan in the Middle East.

You can see that all sources of water on land depend upon rain. Where does rain water come from? As

you know, it comes from the sea. Therefore, we all really depend on the sea for the supply of all the water on land. We actually have a 'cycle' here: from sea to clouds, from clouds to rain, from rain to river, and from river back to sea. This is called the **water cycle** (P3).



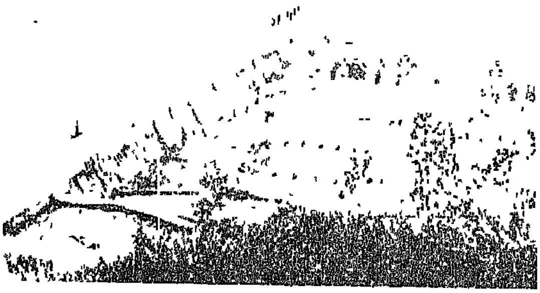
PICTURE 3

(c) The water that we use for cleaning, washing and in industry becomes dirty and is, therefore, allowed to flow through man-made channels, called the **drainage system.** Some of the drain water percolates through the ground; when the same thing happens to it as to percolated rain water. Fortunately, all water is cleaned in the process of percolation. The part of drain water that does not percolate is often processed by man. In this processing, harmful materials present in the drain water are removed. The water is then released into a river or the sea. Unfortunately, in our villages, the drain water is often not processed in this way. It often stagnates in puddles and pools, and becomes a breeding ground for germs and insects which cause diseases in man.

(d) In high mountains, the temperature of the air is low: often lower than that of ice. In such places, the water present in the atmosphere condenses to ice — or snow, as it is generally called. The ice then settles down on the mountains. Ice, unlike most solids, melts under pressure. Therefore, when the layer of ice on the mountain becomes very thick, the pressure on the ice at the bottom of the layer makes it melt. At some places, a part of the ice also melts into water in the summer. The water formed in either case flows down from the mountain and gives rise to a river. Many great rivers of the world, like the Ganga, are formed in this way. Such rivers are **perennial**, that is, they flow all through the year. Rivers that are formed entirely from rain water dry up soon after the rains stop.

(e) Soon after rain, the springs become active and the rivers full, and we see plenty of water around. If we can store some of the river water at this time, we may be able to use it during summer when water is scarce. How can we store this river water? We

can store it by building a **dam** on the river at a suitable place. The following picture shows such a dam (**P**4).



PICTURE 4

The excess water that flows through the river during the rainy season is stored in the man-made lake seen in the background. This lake serves many purposes:

(i) Part of the water in the lake percolates into the ground. This improves the water supply in the wells around the lake.

(ii) Floods are controlled, and the damage caused by them is avoided.

(iii) During the summer, the gates of the dam are opened, and the stored water from the lake is released into the river. In this way, we get a steady supply of water all round the year.

In India we have built many dams on big rivers. The Bhakara Nangal dam, the Nagarjunasagar dam, and the Damodar Valley dam are some of the big dams we have built. The water stored in these dams is being used for:

(i) irrigating the fields where food is grown,

(ii) producing electricity in power stations nearby.

(f) You would now see that every year the seas lose pure water. (Remember, the evaporated water is pure.) The rivers flow into the sea. They carry with them lots of materials, such as salts and release them into the sea. This process has been going on for millions of years. Can you now understand why sea water is salty? Would you expect the sea to become saltier every year?

In the Middle East, between Jordan and Israel, there is a source of water known as the Dead Sea, which is surrounded on all sides by land (**P**5).

PICTURE 5

In fact, the Dead Sea is a large lake! It is not connected with any other sea or ocean. The River Jordan flows into the Dead Sea, bringing with it lots of salts. The water of the Dead Sea is, therefore, very salty — more salty than that of any other water source on earth. It is becoming saltier year by year.

3.3 What is in the water we use?

Water from different natural sources is not the same. In fact, no natural source of water gives us pure water. The water we obtain from such sources always contains other materials in it. Water from different sources differs in the nature and amount of these materials.

Sea-water contains a large amount of common salt and other similar compounds dissolved in it. Water obtained from sources on land contains less salts. That is why sea-water tastes saltier than water on land The water found on land is often called "fresh water".

The nature of the substances dissolved in fresh water varies from place to place. You will find that in some places it is easy to produce lather with soap; in some other places the soap just does not give lather. This difference is due to the presence of different types of salts in the water. Some of them prevent the lathering of soap, while others do not affect the lathering. Water in which soap lathers well is called **soft water**. Water in which soap does not do so is called **hard water**. Which water will you choose for bathing or for washing clothes?

There are several methods that one can use today to convert hard water into soft water. For example, people add lime to certain types of hard water and then filter it, to make the water soft. We can remove all the dissolved salts from water by distillation. Some of these salts separate out of water if it is boiled just for a few minutes. They can then be removed by cooling and filtering the water (This method can, therefore, be used to reduce the **hardness** of water). Rain water falling on the ground, **after the first rain**, is probably the purest form of naturally occurring water. Can you see why?

Very often the water we obtain from sources on land has some suspended materials in it. The suspended material may be living or non-living. The non-living suspended materials most frequently found in natural water are dust and soil. The living objects found in water include bacteria, algae, protozoa (like amoeba), roundworms (called nematodes), water fleas, small insects,

leeches, and eggs of several organisms such as mosquitoes. Many of the organisms found in water are harmful to man. They produce diseases like cholera, typhoid and dysentery. Water from different sources contains different amounts of non-living material and different types of living organisms in it.

Naturally occurring water has always some gases dissolved in it. Remember, the fish live on the oxygen dissolved in water.

Water from different sources tastes different. Sometimes, water from spring contains certain special substances dissolved in it, which give it a special taste. One can often identify the spring from the taste of its water. Some spring waters can help you keep healthy or help in the cure of a disease. The water of some other springs contains harmful substances dissolved in it.

3.4 How do we make water safe for use?

Scientists have discovered some very good methods for purifying unclean water, so that we can use it safely. In order to make the water safe for use:

The suspended impurities should be removed.	This can be done by decantation or by filtering
The **undesirable** dissolved impurities should be removed.	This can be done by chromatography on special materials or by distillation.
The harmful bacteria and other small living organisms should be killed, if they are not removed by filtration.	This can be done by treating the water with a gas called chlorine. At home, this can be done by boiling the water or by adding a small amount of a compound called potassium permanganate. Both, boiling and addition of potassium permanganate, kill the living organisms generally present in water.

3.5 What makes water so useful?

Water possesses several special properties that make it so useful. Some of these properties are mentioned here.

(**a**) It can dissolve a very large number of substance, that is, it is one of the best solvents known. Could you use water for cleaning if it was not a good solvent?

(**b**) It does not become **thinner** when we heat it or **thicker** when we cool it. Try heating materials such as honey, castor oil and glycerine and see how much thinner they become. Can you say what would have happened to living organisms such as plants, if water became very thick on cooling and thin on heating?

(**c**) You will find that solid forms of most materials are heavier than their liquid forms. In the case of water, ice is **lighter** than water. Ice, therefore, floats on water. Let us now see how this special property of water is useful for life.

During winter, a lot of water freezes into ice in the polar regions. Ice is lighter and floats on water. Ice is also a bad conductor of heat. The frozen layer of ice, therefore, protects the liquid water below it from the cold outside. In other words, the layer of ice on the top does not allow the heat of the water below it to go out. Therefore, only the top part of the water remains frozen. The water below the layer of ice stays comparatively warm. It is in this water that the fish, the shrimps and rest of the **aquatic** animals, live through the winter. When summer comes, the ice melts and the animals can come to the surface again

What would have happened if ice were heavier than water? In that case, the frozen ice would have sunk to the bottom of the sea every winter. During summer, the atmospheric heat would not be able to reach the bottom of the sea. Why? Remember that seas are often very very deep, and also that water is a bad conductor of heat. Therefore, most of the ice settling at the bottom of the sea in winter would not melt in summer. In the following winter, more ice would be added to the bottom of the sea. Eventually, most of the sea would turn into ice. Do you think life would be as abundant on our dear planet earth then, as it is now?

(**d**) Water is transparent to visible light. That is why light is able to penetrate to great depths in water, making it possible for fish and other animals in the water to see. Had water been opaque, much of the life we see in water might not have been possible.

4. ACTIVITIES

4.1 Taste water collected from as many different sources as you can

conveniently find, such as water from the city water supply, water from different wells, rivers, lakes and ponds, rain water and sea water. Is there any difference in their taste? Can you list the reasons for the differences in their taste?

4.2 Leave the water you drink undisturbed in a closed container for several days. Do you find some residue at the bottom of the container? What does this experiment show?

Decant the water from the above container, without disturbing the residue, into an open container. Leave the water to evaporate in the sun. Wait till the water has evaporated. Do you find anything left in the open container? If so, where did it come from? What does this experiment tell you?

Repeat the experiment with the same amount of water from different sources. Do you get the same amount of residue left in the open container?

4.3 Observe for a few days what happens when you stop watering a plant (other than a cactus) grown in a flower-pot. What does this experiment show? And why not a cactus?

4.4 Collect water from different sources, as in 4.1. Using a hand lens, try to find out how many different types of suspended impurities are present in each sample.

4.5 Take 1 kg of leaves of any plant and allow them to dry in the sun. Weigh again and write down your observation. Dry the leaves further by heating them on a fire and weigh them again. Does the sun remove all the water contained in the leaves? Repeat the experiment with one potato (to speed up drying, you can cut it into thin pieces). Which has more water: potato or the leaves you chose?

4.6 Keep water in a glass tank for a month. Do you find some green plants growing on the inner side of the glass? If you do, try to explain how it happened.

4.7 Collect water from different sources as in 4.1. Try to produce lather with soap, using the different water samples. On the basis of your observations arrange the water samples in the decreasing order of their hardness.

4.8 Make a list of substances which can dissolve in water easily.

4.9 Each town or village usually has at least one big source of water. Try to arrive at the answers to the following questions:

(**a**) How did the water get there?

(**b**) Is the water from this source pure?

(**c**) If it is not pure, what is the impurity and how did it get there? What can be done to purify this water?

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

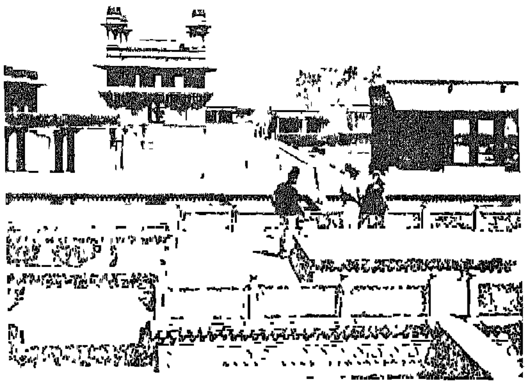
5.1 Water, water everywhere!

We have learnt that water is one of the most abundant materials available to man. Man can obtain water from a variety of sources. Water from different sources has different properties. Water is useful in many ways. We have learnt about several special properties of water that make water so useful.

5.2 Water and man

No life, as we see it, would be possible without water. We all are mostly water. If we study history, we will find that man always chose to live in places that were near water. Most of the historic cities in our country (as well as outside the country) are situated near large sources of water: Delhi, Agra and Allahabad (on river Yamuna); Allahabad, Varanasi, Patna, and Calcutta (on river Ganga); Rajahmundry (on river Godavari); Vijayawada (on river Krishna) and Tiruchi (on river Cauvery). Can you name other cities in our country and abroad which are situated near large sources of water?

Emperor Akbar built a beautiful city called Fatehpur Sikri (**P**6). He had to abandon it soon because there was not enough water there.



PICTURE 6

5.3 Take care of your water!

We have learnt that the water we get from natural sources is not always pure. It contains many impurities which are harmful to man We can, however, purify water and make it safe for our use. Often we can **prevent** water from becoming impure. For example, we can cover open wells, and we can avoid cleaning dirty utensils and washing dirty clothes near the source of water. Throwing of human and animal wastes and other waste materials, and bathing ourselves or animals near the source of water we use also makes water impure.

We have learnt that water, like air, is essential for life. No one should claim an exclusive right on water. We must learn to share water and to conserve it. For conserving water, we

should ensure that we do not waste it, that we use it only when needed, and that we protect it from loss wherever we can. For example, wherever we have springs feeding water to wells or tanks, it is our duty to make sure that the springs do not get choked by mud.

5.4 Take care of yourself

Many diseases caused by dirty water can spread very easily amongst a large number of people in a short time. We can protect ourselves from such diseases by getting ourselves inoculated against these diseases periodically. You can obtain these inoculations free of cost in your village or town.

CHAPTER 14

ENERGY

1. OBSERVATIONS

1.1 When we work for some time, we feel tired. When we are tired, our ability to work decreases. You might have heard a friend say, "Ashok is quite energetic", or "I have no energy left for doing any more work". By these statements we mean that Ashok has a lot of energy and can, therefore, do a lot of work. Or I have very little energy left to exert the **force** necessary for doing work. It appears from these phrases that **energy** and **doing work** are related.

1.2 The hands of a clock move. An arrow can be shot out of a bow at considerable speed; so can a stone out of a catapult. From where do the hands of a clock — or the arrow or the stone — get the energy to move?

1.3 When we heat some water in a vessel, the temperature of the water rises and, eventually, the water begins to boil. If we keep a lid on the vessel, the steam often makes the lid move up and down (**P**1).

PICTURE 1

A young man called James Watt saw the lid of a kettle being moved by the steam from boiling water. He wondered whether steam could be made to move bigger objects. It was this idea of his that led to the development of steam engine. Can you recall

other agents, like steam, which can make things move, that is, do work?

1.4 Motor cars, trucks and tractors move and do a lot of work for us. Generally, a car needs petrol to move. Trucks and tractors need diesel. Why do we need to supply **fuel** (petrol or diesel) for these machines to work? Why do they stop working when the fuel is used up?

1.5 You have seen a torch or transistor which works on cells. When the cells are used up, the torch or the transistor does not work. We have to put in fresh cells in the torch or the radio to make it work again.

When we are tired, we find it difficult to do more work. We also feel hungry. We, therefore, eat food. After we have eaten, we often feel fresh again and are able to do more work.

Do you think the act of putting fresh cells in a torch and the act of eating food are similar? If so, in what way are they similar? And what are the differences?

1.6 How does a bicycle or a bullock cart move? The bicycle moves due to the effort put in by the rider. The cart is pulled by the effort of the bullocks. Do the man and the bullocks use any energy? If so, where does this energy come from?

1.7 When we cut wood, an axe is brought down upon a piece of wood

PICTURE 2

(P2). The moving axe enters the wood and splits it. If the wood is tough, we have to move the axe faster. We spend more energy when we move the axe faster. Where does the moving axe get its energy from?

You must have seen people breaking stone with a hammer (P3). When the moving hammer falls on the stone, the **force** of the hammer breaks the stone. The larger the force of the hammer, the greater would be the work done by it. Where does the energy for doing this work come from?

1.8 When we light a match-stick, it catches fire and emits heat and light.

PICTURE 3

From where do the heat and the light come? Were they hidden in the match-stick? And if so, how were they hidden and how could they be released?

1.9 During Diwali we use crackers. Is any energy released when a cracker explodes? If so, how was this energy stored in the cracker? Is the sound that a cracker makes also energy?

1.10 By operating a switch, we can put on an electric bulb or start a fan. We find electricity doing so many other jobs for us. Is electricity also energy?

2. QUESTIONS

2.1 We have already asked several questions above. Let us add to them a few more that you may like to ask.

(a) What is energy?

(b) Are there different types of energy?

(c) When we say, 'we use energy', what do we really mean?

(d) What are the sources of energy in nature?

(e) Can we find new sources of energy?

(f) How best can we make use of the energy available to us?

3. LET US FIND OUT

3.1 Energy is the ability to do work

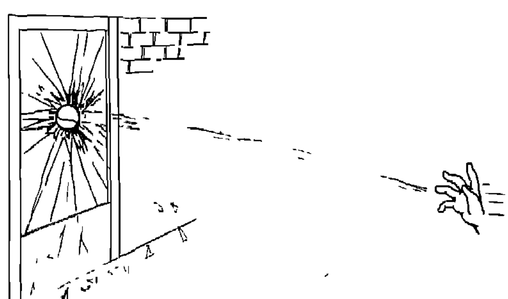
We have already seen that we need a force to move something. When we apply force and bring about a change

in the motion of an object, we say that **work** is done.

In fact, energy is simply a measure of the **ability** to do work or to exert force. Energy is always **required** for doing work or for exerting a force. Energy is, therefore, essential for moving anything. Remember, our daily life is full of motion. We, therefore, use a lot of energy day and night. From where do we get this energy? In other words, what are the **sources** of the energy we use?

3.2 A moving object is a source of energy

A hard cricket ball placed on a sheet of glass does not damage it. But even a soft tennis ball moving at high speed can shatter glass (**P**4). When glass shatters, the glass pieces move. From where did the energy for this movement come? And from where did the ball obtain the energy to shatter glass? Obviously, the motion of the ball gave it the energy to shatter glass and to move the broken pieces.



PICTURE 4

You will find many examples around you of objects possessing energy because of their speed. We can carry bullets very safely in our pocket. We dare not stand in the path of a bullet fired from a gun.

You know that wind has the ability to move sail-boats. When the wind stops, so does the sail-boat Similarly, **running** water can make the blades of a watermill move. Wind and water can cause erosion, that is, move the soil away. It is the motion of the wind and the water that gives them the energy to move objects.

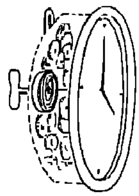
Any moving object can, in fact, be used as a source of energy. Can you think of some more moving objects which we can **use** as sources of energy?

3.3 Potential and kinetic energy

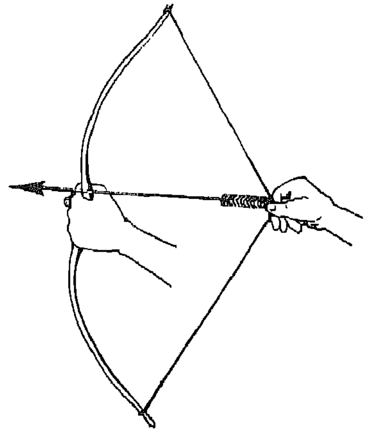
In each of the following examples (**P**5 to **P**9) work is done in a special way. Can you say how the energy is obtained to do the work?

(i) A wound up spring.	When such a spring unwinds, it can drive the hands of a clock.
(ii) A stretched bow with an arrow.	When the bow is released, the arrow is shot out with great speed

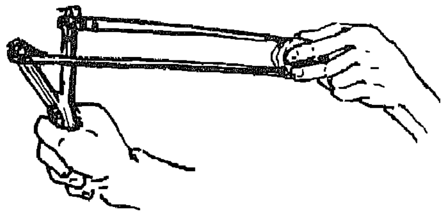
(iii) A stretched rubber catapult with a stone on it.	When the catapult is released, the stone moves away with speed.
(iv) A stone kept on the edge of a cliff under which a tiger is sleeping.	When the stone is pushed, it falls through a large height. When it strikes the tiger on the ground, it can kill the tiger.
(v) A pendulum held by hand at one of its extreme positions.	When released, the pendulum begins to oscillate.



PICTURE 5

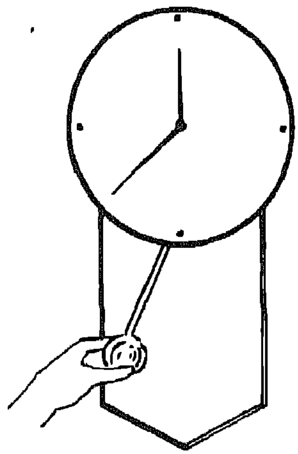


PICTURE 6



PICTURE 7

PICTURE 8



PICTURE 9

In the foregoing examples, the system on the left-hand side is capable of doing the work mentioned on the right. The spring, the arrow, the stone in the catapult, the stone on the cliff, and the pendulum, all have energy because of their **position**. This energy is, of course, hidden but we can easily release it and convert it into the energy of motion. We have special names for the two forms of energy: the energy hidden in an object on account of its position, and the energy in an object due to its **motion**.

The objects on the left-hand-side — the spring, the arrow, the stone in the catapult, the stone on the cliff, and the pendulum — are not moving. They, however, are capable of doing work, that is, they have the **potential** to do so. They are, therefore said to have **potential energy**.	The objects on the right-hand side are moving and are said to have **kinetic energy**.

When we release the objects of the left-hand column, potential energy is **converted** into kinetic energy. Can you give other examples of the conversion of potential energy into kinetic energy?

3.4 Chemical energy

There is also energy hidden in molecules, that is, in compounds (which, you will recall, are made of molecules). A part of this energy is often released when the molecules take part in a **chemical** change. This energy is called **chemical energy**. It is the chemical energy hidden in the chemicals of the match head that gives us light and heat when the match is struck. The chemical energy of petrol or diesel is used to run a car or a truck.

One form in which we use chemical energy very frequently — in fact **all the time** — is muscular energy. Muscular energy is a kind of energy we are capable of producing in our own body. It is on account of muscular energy that all animals are capable of exerting force. When we lift a load, or when a bullock pulls a cart, muscular energy is used.

Have you seen an ant carrying a grain of sugar? The ant also uses its muscular energy to move the grain of sugar.

We obtain our muscular energy from the food we eat. As we have already seen, the compounds in the food undergo many chemical changes in our body. In this process, they produce energy. Some of this energy is stored in our muscles and is called muscular energy.

We can make better use of our muscular energy by using simple devices like the pulley or the inclined plane, the wheel or the screw. You have learnt how these simple machines enable us to do things which would be otherwise harder to do. Simple machines have been used by man for a very long time. Those who learnt to use them progressed faster, as they had an advantage over those who did not.

The invention of the wheel and of the stirrups for riding horses, allowed man to use the muscular energy of animals more efficiently. However, it is only the discovery of **new** sources of energy, such as coal, petroleum, electricity and **atomic energy**, which enabled man to progress really fast.

3.5 Sound, heat and light

Sound, heat and light are also forms of energy. You may find it difficult to believe this because, in our everyday life, we do not generally notice sound, light or heat moving any object. How, then, can we say that they really are forms of energy?

When a *tabla* player hits the tight skin on the *tabla*, the skin begins to **vibrate** (that is, move) and produces a sound. The sound made by a *sitar* is also due to the vibration of its strings. The reverse is also true: sound can set things vibrating. When a loud thunder occurs, you can sometimes feel the whole house shake for a moment. Therefore, sound **is** able to move things. **Sound is energy.**

Light is a very **feeble** type of energy. When you shine light on a bullock cart or a motor car, they do not move. They are too heavy to be moved by an ordinary beam of light. Light can, however, move an object if it is very light, such as a part of an atom. Of course, if the beam of light is **extremely** powerful, it can also push **heavy** objects. For example, very intense sunlight falling on a comet pushes the dust particles surrounding the comet away from the sun; as you know, it is these particles pushed by light that give a comet its tail. The tail disappears when the comet goes far away from the sun. The amount of light falling on the particles then becomes small.

You have already learnt that all materials are made of atoms and molecules under normal condition. The atoms and molecules are never at rest: they are moving all the time. In a solid like ice, their motion is very small and slow; in a gas such as steam, they move much faster and are free to move all over the available space; in a liquid like water, their motion is in between that in a solid and a gas. When you heat any object, the atoms and

molecules of that object begin to move **faster**. Would you now agree that heat is also a kind of energy? It **can** bring about a change in the motion within an object.

3.6 Fuels

(**a**) Heat is a form of energy we use very often. We can obtain heat when we **burn** some materials. Burning is a chemical change in which the molecules of a material combine rapidly with oxygen molecules; heat is usually released in this process. When we burn wood or coal, the molecules in wood (or coal) combine with the molecules of oxygen and liberate heat. Not all materials can be burnt. For example, we cannot burn water and obtain heat from it.

Only certain materials have the property of combining **rapidly** with oxygen and releasing a **lot** of heat in the process. Such materials are called **fuels**. We can, therefore, say that when we burn fuel, we are converting the chemical energy of the fuel into heat energy.

(**b**) Kerosene and petrol are two commonly used fuels. They both come from a substance called **petroleum**. Petroleum consists of a mixture of many materials such as kerosene, petrol, wax and naphtha (a substance used in fertilizer industry). Since these materials boil at different temperatures, we can use the method of distillation, described in Chapter 3, to separate them. Petroleum — or crude oil as it is often called — is obtained from special **wells** and is taken to **refineries** where the above products are separated.

Very recently large deposits of petroleum have been discovered near Bombay, under the sea. Wells are being dug to recover this petroleum.

(**c**) When we burn a fuel, say, wax, kerosene or coal, we get both **heat** and **light**. But we generally say that a wax candle or a kerosene lantern gives light while a coal *sigree* gives heat. Is this really true? The candle and the lantern give heat as well: touch the lantern and you will know. Similarly, coal in the *sigree* gives light too; keep the *sigree* in a dark room and find out for yourself.

The statement: '*sigree* gives heat' therefore means that it gives **mostly** heat. It does not mean that *sigree* does not give any light. Similarly, when we light a candle or a lantern we get mostly light but we also get some heat. An *agarbatti* gives light (you can see a lighted *agarbatti* in the dark), heat and a gas (smoke) which smells good. But we don't light an *agarbatti* for heat or light; we light it for its lovely smell! You will find that it is important to

bear this point in mind. An object may do several things, some well and some not so well. We choose it to do – and it comes to be known for — what it does best.

(**d**) The fuels we burn commonly are wood, kerosene (and other materials obtained from petroleum), coal and cowdung. We have already seen that it would be more economical to use cowdung to produce the fuel, *gobar gas*.

Wood, coal and petroleum are all obtained from plants. Coal and petroleum have been formed from dead plants, buried deep under ground for millions of years. Since plants get all their energy from the sun, we can say that these fuels are really stored forms of solar energy.

Whatever coal and petroleum we now have on our earth were formed a very long time ago when the conditions for the formation were right. As far as we know, they are not being formed any more.

3.7 Electricity and magnetism

Electricity is a relatively new form of energy discovered **only about a hundred years ago.** We, of course, **now** use electricity widely – in agriculture (for example, for pumping water), in industry and at home. It has rapidly replaced wood, coal and petroleum in many parts of the world.

Another type of energy known to man since ancient times is magnetic energy. We have already seen in Chapter 3 how magnets can be used to pick up and move certain types of objects such as iron.

3.8 Atomic energy

We have seen how we can use the chemical energy stored in molecules. Scientists have realized that even atoms have energy hidden in them. In fact, atoms are by far the most powerful source of energy known to man. It is today possible to control atomic energy to get a steady supply of energy for peaceful purposes In India, we have **atomic power plants** in Tarapore and in Trombay (Bombay). These plants convert atomic energy into electricity. More of such power plants are being built.

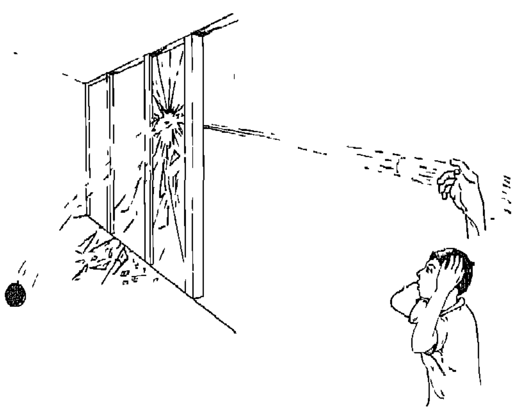
We have said above that fuels like wood, coal and petroleum are really stored forms of solar energy. Where does the sun get its energy from? It has now been realized that most of the energy of the sun is atomic energy. In other words, the sun is a gigantic natural atomic power plant. So are other stars. The sun and the stars convert atomic energy into heat and light that we get from them.

3.9 One form of energy can be converted into another

What do we mean when we say we use energy? What happens when energy is used to perform some work? Let us examine one or two examples and find out.

A ball moving at a high speed has energy due to motion. When this ball strikes a glass pane, we have (**P10**)

(i) a loud sound	due to sound energy
(ii) broken glass and flying splinters	due to energy transferred to the glass; some of this energy is used to break the glass and some to make the glass pieces move further.
(iii) the ball slowing down	due to the ball having lost some energy, and due to friction.



PICTURE 10

In the example given above, the kinetic energy of the ball was partly converted into sound energy and partly into the kinetic energy of the broken glass pieces A part of the energy of the moving ball was used up in breaking the glass

Let us take another example. A fire-cracker consists of some explosive powder (chemicals) wrapped in a piece of paper. The powder contains chemical energy When we fire the cracker, the chemical energy contained in it is converted into.

(**i**) a loud sound, that is, sound energy;
(**ii**) a flash of light, that is, light energy;
(**iii**) burning, that is, heat energy; and
(**iv**) flying pieces, that is, kinetic energy.

We can therefore convert one form of energy into one or more of the other forms of energy. When this is done, we say that energy has been **used**. All **engines**, in fact, convert one form of energy into another.

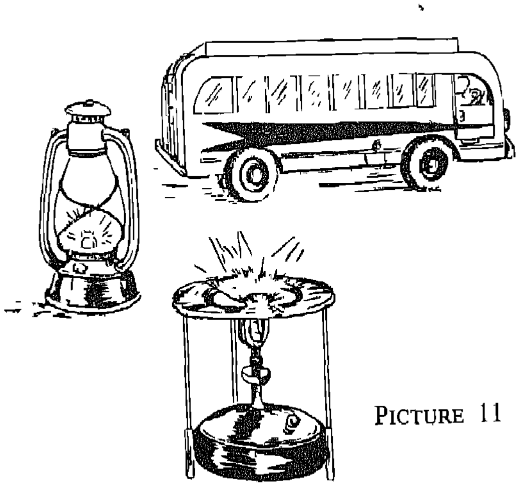
Let us look at some other examples in which we convert one form of energy into other forms in daily life.

3.10 Loss of energy during conversion

Whenever we convert one kind of

Chemical energy contained in petroleum products (P 11)

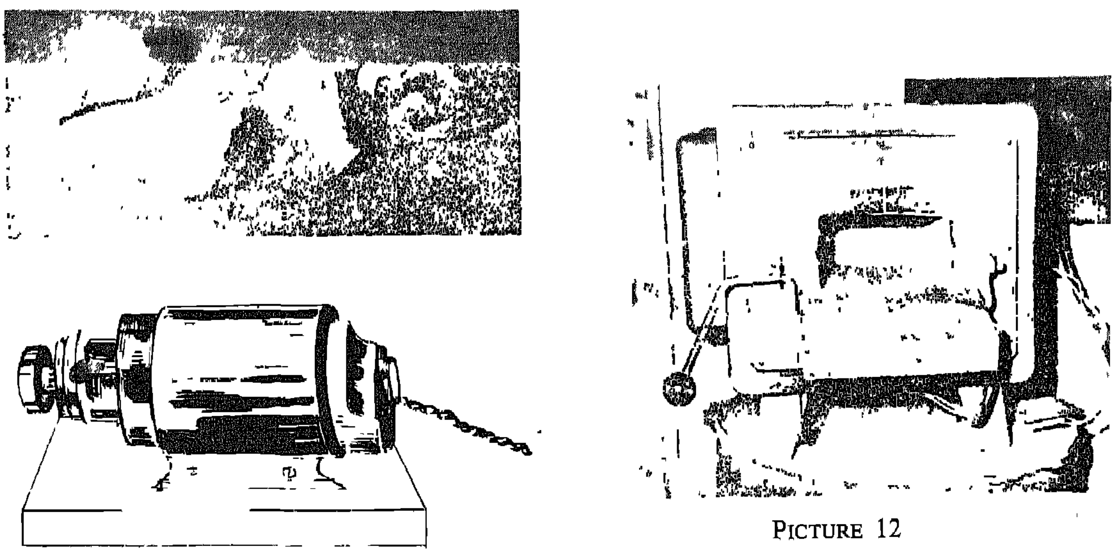
- Lantern → Light (mainly)
- Stove → Heat (mainly)
- Diesel engine of a bus → Motion (mainly)



PICTURE 11

Electricity
P 12

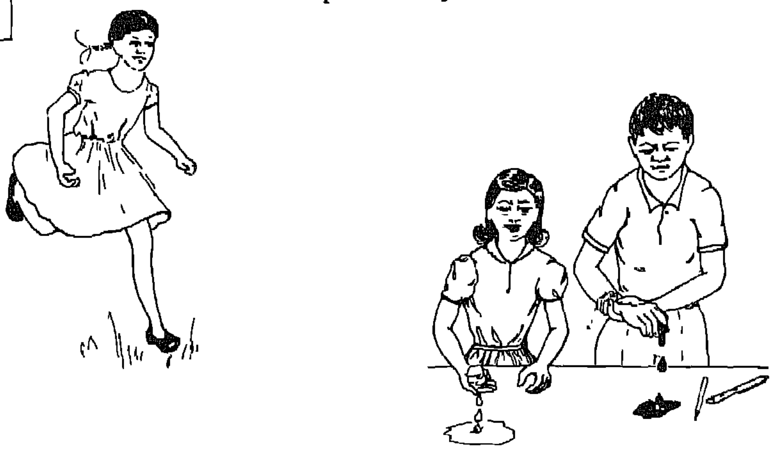
- Bulb → Light (mainly)
- Furnace → Heat (mainly)
- Motor → Motion (mainly)



PICTURE 12

Chemical energy contained in food (P 13)

Me → Motion
Me → Chemical energy to replace worn out and damaged parts
Me → Heat to keep the body warm



PICTURE 13

energy into another kind, there is always some loss. For example, if we first convert a given amount of heat energy into energy of motion and then convert the energy of motion back into heat energy, we will get a lesser amount of heat energy than what we started with.

One of the things we look for in a machine is efficiency. A machine would be 100% efficient if it converts **all** the energy it took in into the desired effort. No machine can, however, be 100% efficient. We know that a machine uses some energy to overcome friction. We also know that there is wear and tear in the machine with use. There are also other losses such as those due to unwanted heat (as in an electric bulb) or sound. All the energy put in a machine cannot, therefore, be converted into the desired effort.

4. ACTIVITIES

4.1 Make a list of all the sources of energy which are used in your locality.

4.2 List all your activities during a day in which you have to spend some energy. Remember that some energy is always needed by the heart to pump blood, by the lungs to expand and contract, and by the whole body to main-

tain its temperature.

4.3 Can you identify all the cases around you in which one form of energy is converted into another? Identify in each case, the starting form of energy as well as the final form (or forms) of energy. Are there any cases in which one form of energy is converted into **several** forms?

4.4 Using a hand lens (magnifying glass), try to focus sunlight on a piece of paper for a few minutes. Record your observations. Does this experiment help you to understand that light is a form of energy?

4.5 Take some water in a glass and find out its temperature. Add a little quicklime to the water and stir it for a few minutes. Now measure the temperature of the mixture. You will find that the temperature has risen. Can you name the type of energy which is responsible for the rise in the temperature of water? If a thermometer is not available, you may note the change in temperature by simply touching the outer surface of the glass. Can you guess why we are not advising you to dip your finger into the glass?

4.6 Light a kerosene lamp or a candle and try to focus its light on a sheet of paper using a hand lens. Keep a thermometer at the point where the light is focussed and record the rise in temperature every minute, until the temperature stops rising (this will take only a few minutes). Record the highest temperature reached. Leaving the thermometer where you kept it, now keep a hot iron or a kettle containing boiling water near the lamp, and record the change in the reading of the thermometer after five minutes. How does this experiment help us in understanding that heat is a form of energy? What else does this experiment tell us?

4.7 Heat the same amount of water (about half a litre) using different sources of heat energy —a candle, a gas stove, a coal fire, a kerosene stove and an electric heater — for the same interval of time (say, 10 min). Find out the change in the temperature of water in each case. Do you think the energy received by water from different sources is the same? If not, which source gave the maximum energy to the water?

4.8 Inflate a balloon and release it from your hand without tying the end. What do you observe? You know we always need energy to move an object. Can you explain from where the inflated balloon got its energy to move? Can you name the type of energy which made the balloon move?

4.9 Release a glass marble from some height and observe its motion till

it comes to rest. Make a list of all the conversions of energy from one form into another during the entire process.

4.10 Make a list of sources of energy other than those talked about in this chapter, which you think man can use in the future. Have a class discussion on this subject.

5. WHAT HAVE WE LEARNT AND HOW IS IT RELEVANT?

5.1 We use many different forms of energy

We have learnt that force is needed to do work. Energy is the capacity to do work or to produce a force. In daily life, we come across many forms of energy. Some forms of energy are: kinetic energy, potential energy, electrical energy, magnetic energy, chemical energy, heat energy, sound energy, light energy and atomic energy. Notice that all these types of energy get their names from their sources.

5.2 All forms of energy are related

We have seen many examples where conversion of one form of energy into another occurs. An interesting example of such conversions is a hydroelectric station near a dam. In these stations, the potential energy of stored water is converted into electricity. Let us see how this happens.

Water is stored in the lake made by the dam which is at a height. The water therefore has potential energy.

The water is allowed to fall through the height of the dam. In this process, the potential energy of the water is converted into kinetic energy.

The water falls on the pans of a machine called a generator, making the generator wheels rotate fast. In this step, the kinetic energy of the water is converted into the kinetic energy of the generator.

The generator produces electricity. In this process, the kinetic energy of the generator is converted into electrical energy.

The electricity produced is transported to far away places through wires. We know how electrical energy can be converted into other forms of energy such as heat and light. We also use electricity to pump water from rivers or lakes into fields; when we do

so, we are converting electrical energy into kinetic energy.

Conversion of energy from one form to another takes place in many situations. Whenever such conversion occurs, there is always loss of some energy. This loss occurs due to conversion of the starting energy into several **undesirable** forms such as friction, heat and so on, in addition to the desired form of energy.

5.3 The sun is the main source of energy on the earth

We have seen that almost all sources of energy on the earth may be traced to the sun which is a gigantic atomic power plant. We know that the energy of the sun is responsible for the water cycle and for the change of seasons. Plants store solar energy in the form of chemical energy. This stored energy in plants is used by man and other animals in the form of food. Similarly, coal and petroleum are the result of conversion of solar energy into chemical energy.

This conversion has taken place slowly over millions of years, and will not happen again.

5.4 The energy: past, present and future

Man's requirements of energy have been continuously increasing. In this century, they have been increasing at a very rapid rate. To meet these requirements, man has looked for new sources of energy. He discovered the chemical energy hidden in molecules and that contained in petroleum and other fuels. He also discovered how to use the heat energy hidden in steam, and made a steam engine. Discoveries such as these have made it possible for man to produce a variety of goods on a large scale. These goods have made the life of a large number of people around the world so much easier and more comfortable. It must, of course, be remembered that the fruits of this change have not yet reached **all** the people of the world, and we must do our best to see that this happens.

The discovery of electricity has an important place in the history of energy, as we can easily store and transport electricity and convert it into many other types of energy. We use several different sources of energy to produce electricity.

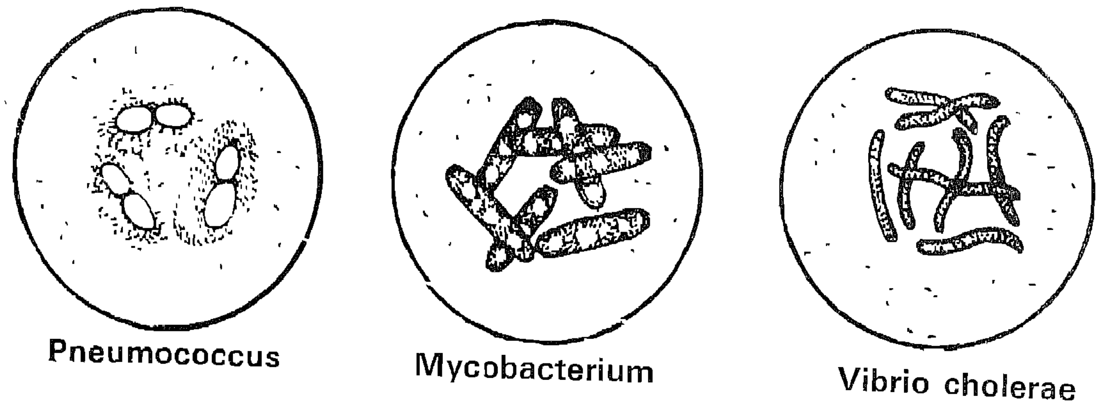
For the last 30 years, it has been possible to convert the energy hidden in the atom (the atomic energy) into electricity.

We should realize that the amount of natural fuels we have on the earth is limited. Moreover, we do not have enough energy in our country today to meet all our needs. Many villages, for

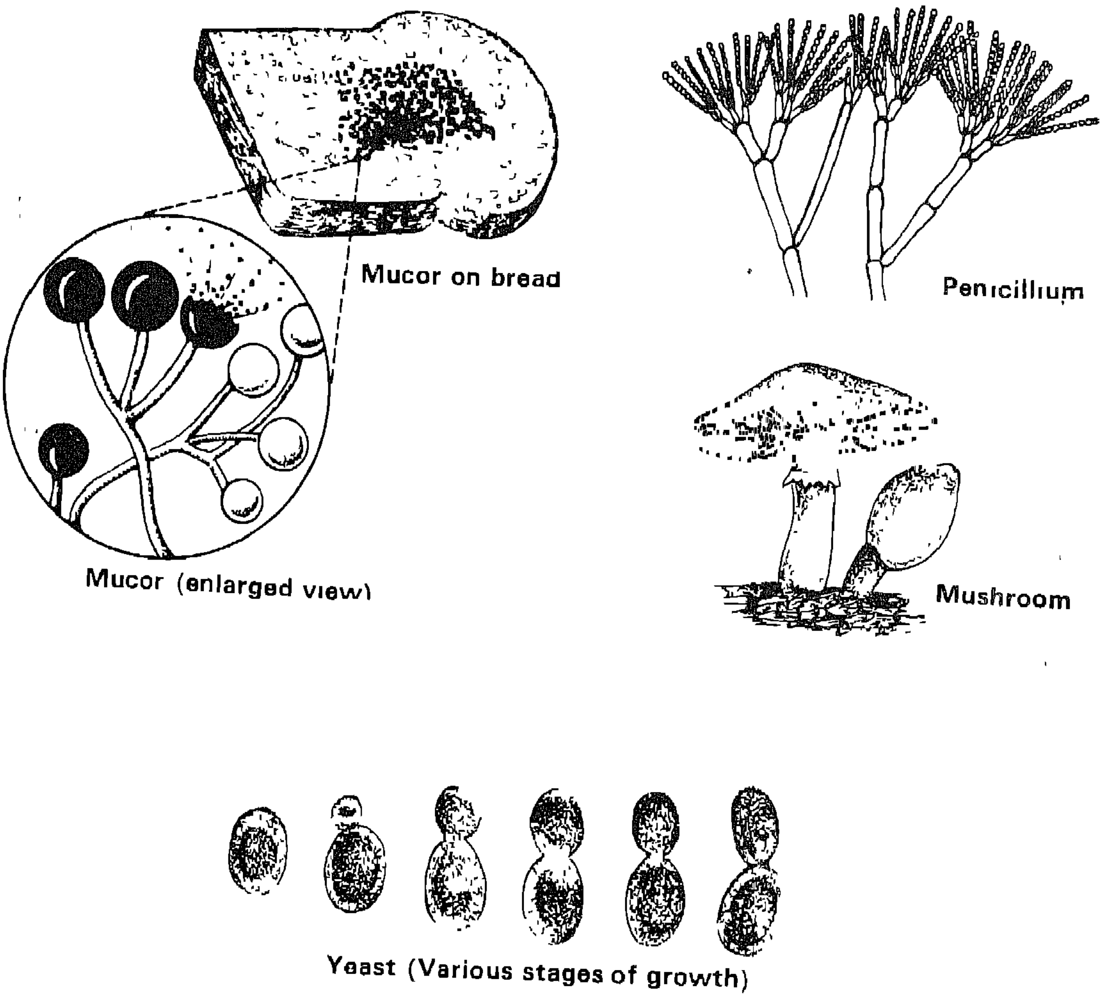
example, do not yet have electricity. Therefore, we must use the energy we produce with care and economy. We can practise economy in the use of energy in our daily life in many ways. If we are doing work that does not need bright light, we can use a bulb of lesser power, or we can lower the wick of the lantern. This will save electricity or kerosene. We should use buses and trains more than cars and scooters. Cars and scooters use more energy per person. For short distances, we can walk or use bicycles. We should also try to use energy sources that are easily available in our locality. One such source is *gobar gas* which is easily and inexpensively made from cowdung (*gobar*).

There are still many natural sources of energy that man has not yet been able to harness. For example, twice everyday huge tides strike the shores of our oceans. The total energy of the tides is tremendously large. Energy released by cyclones and earthquakes is also very large. Unfortunately, we have not yet found methods of harnessing such sources of energy. If man develops methods of controlling natural forces such as tides, cyclones and earthquakes, that is, if he can make use of these forces to produce energy in a form we can use — our energy problems will probably be solved.

Interesting Information



PICTURE 1

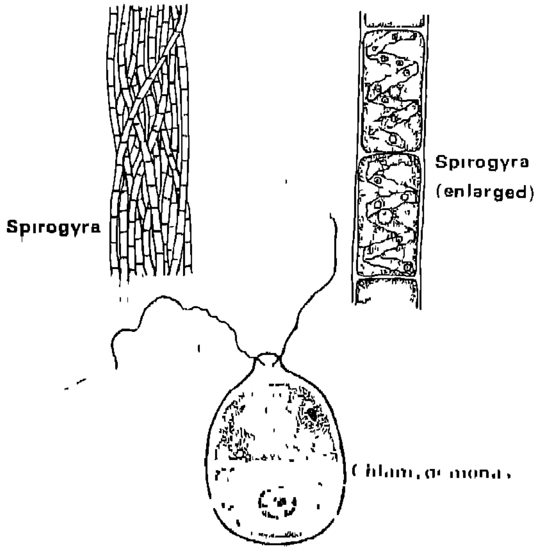


PICTURE 2

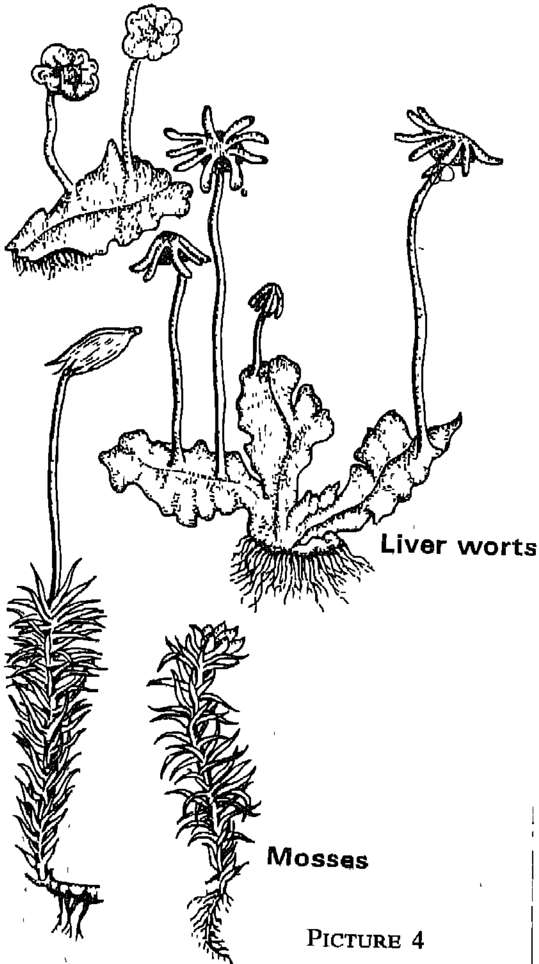
SET 1

GROUPS IN WHICH MOST LIVING ORGANISMS CAN BE CLASSIFIED

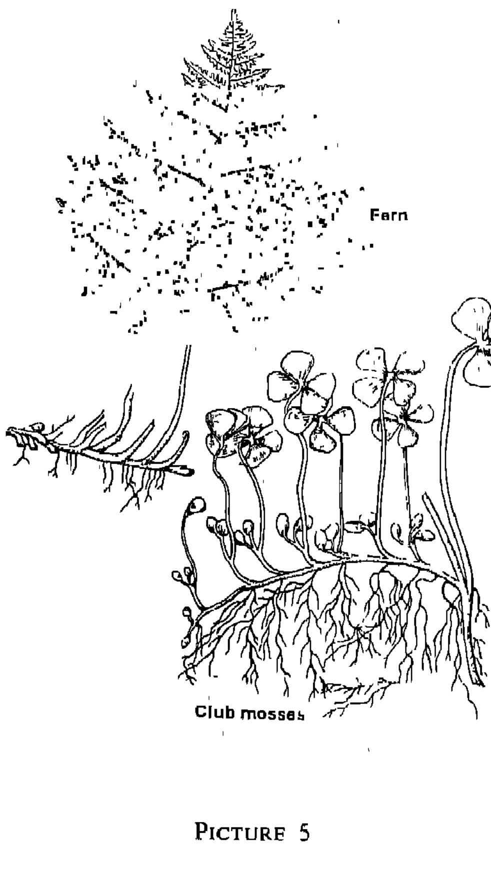
No.	*Common name of the group*	*Scientific name of the group*	*Plant or animal*	*Some important features of the group*	*Examples*
(1)	(2)	(3)	(4)	(5)	(6)
1.	Bacteria	Schizomycophyta	Plant	Very tiny; cannot be seen with the naked eye Single celled (the entire organism consists of just one cell) Found in various shapes, such as elongated, dot-like or spirally coiled	*Lactobacillus* Helps in converting milk into curd *Pneumococcus* Causes pneumonia *Escherichia coli*: Causes colitis (a disease of the intestine) *Mycobacterium tuberculosis*: Cause tuberculosis *Vibrio cholarae* Cause cholera *Salmonella typhi*: Cause typhoid
2.	Moulds and mushrooms	Fungi (Thallophyta)	Plant	Do not have flower The body is not distinguishable into root, stem and leaf Small in size Non-green Usually fine thread-like in appearance	*Mucor* Grows on rotten bread and fruit **Yeast**: Causes alcoholic fermentation *Penicillium*: Used for preparing life-saving drug, penicillin **Mushrooms**. Can be more



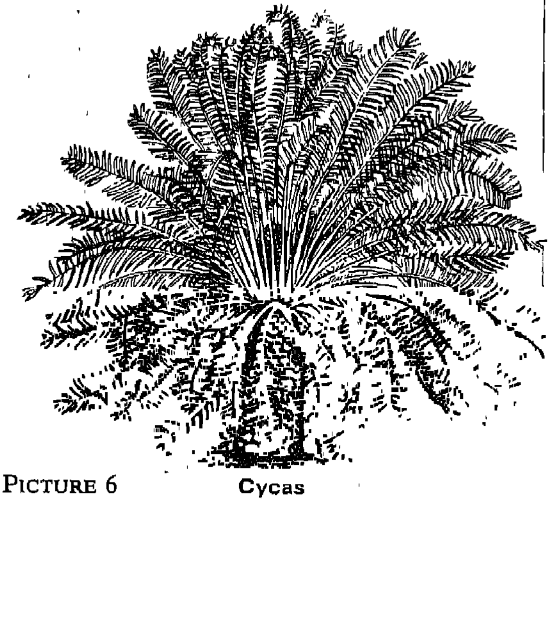
PICTURE 3



PICTURE 4

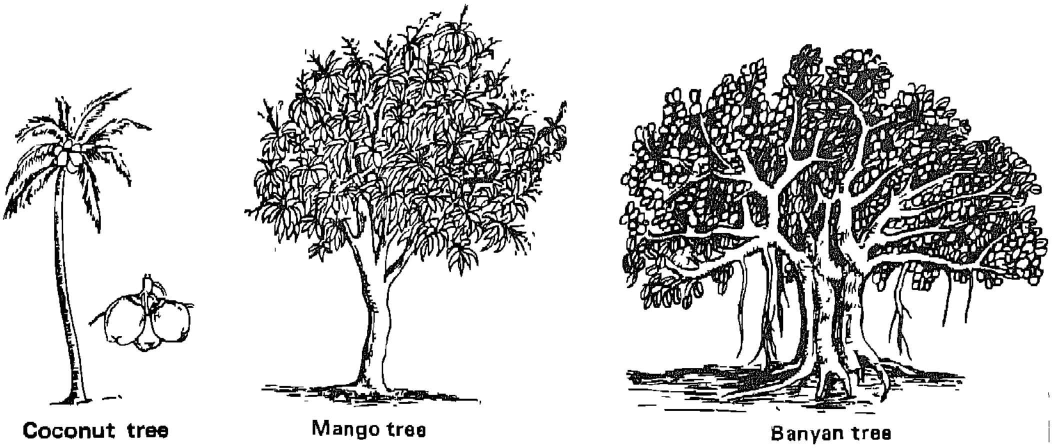


PICTURE 5



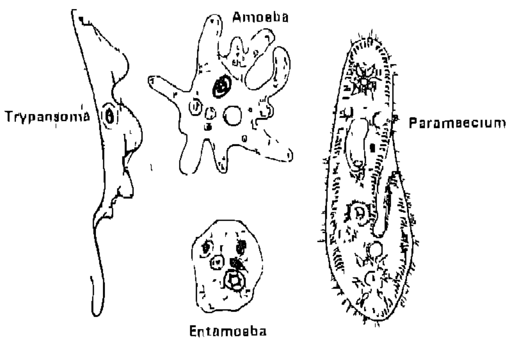
PICTURE 6 Cycas

(1)	(2)	(3)	(4)	(5)	(6)
				Live on dead or decaying organic matter	than 25 cm in size; some are eaten as food
3.	Algae	Algae (Thallophyta)	Plant	They are mostly green (sometimes brown or red) and live on surface of water or on a moist surface on land Do not have flower The body is not distinguishable into root, stem and leaf Small size	*Spirogyra*: Green thread-like; often found floating on ponds. *Chlamydomonas*: Swims freely in water
4.	Mosses and Liverworts	Bryophyta	Plant	Do not have flowers, but most of them have small stem-like structure, bearing tiny leaves Remain attached to the soil by very small root-like parts Small in size Grow in moist, shady places as green velvety patches	**All Mosses** **Liverworts**: Their body is simpler than that of the mosses
5.	Ferns	Pteridophyta	Plant	Do not have flowers Roots stem and leaves are clearly seen Green in colour Generally very small; only a few are big	**Ferns**: Are common as garden plants **Club mosses**: Usually found in the mountainous parts of the country

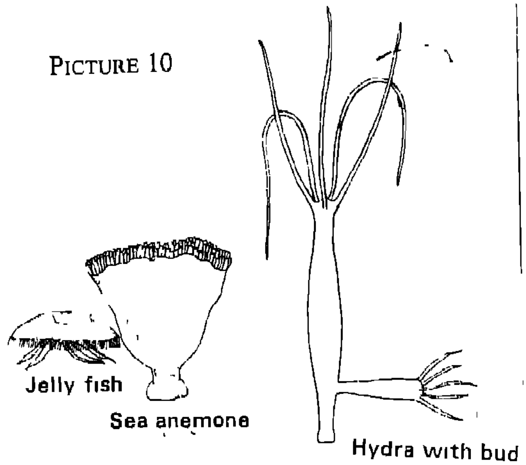


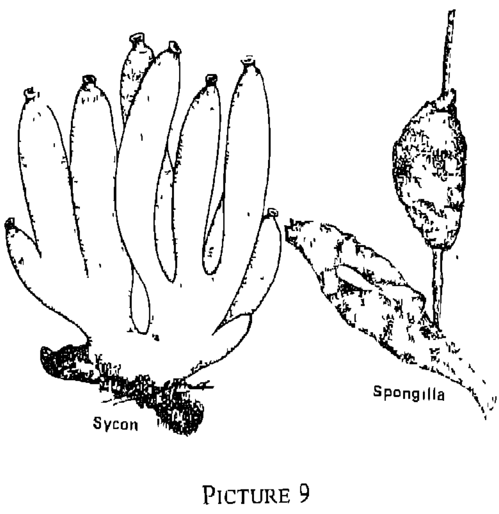
PICTURE 7

PICTURE 8

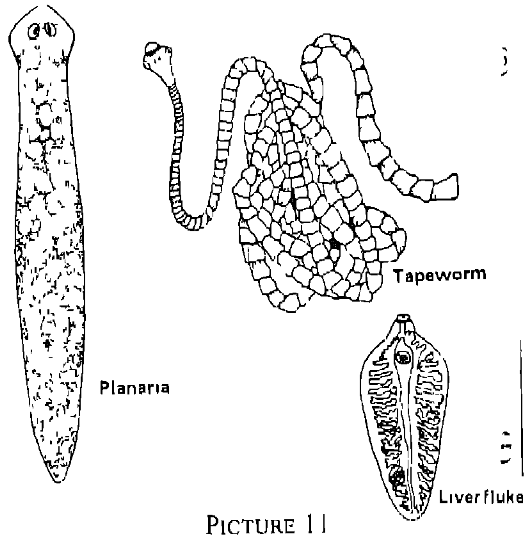


PICTURE 10



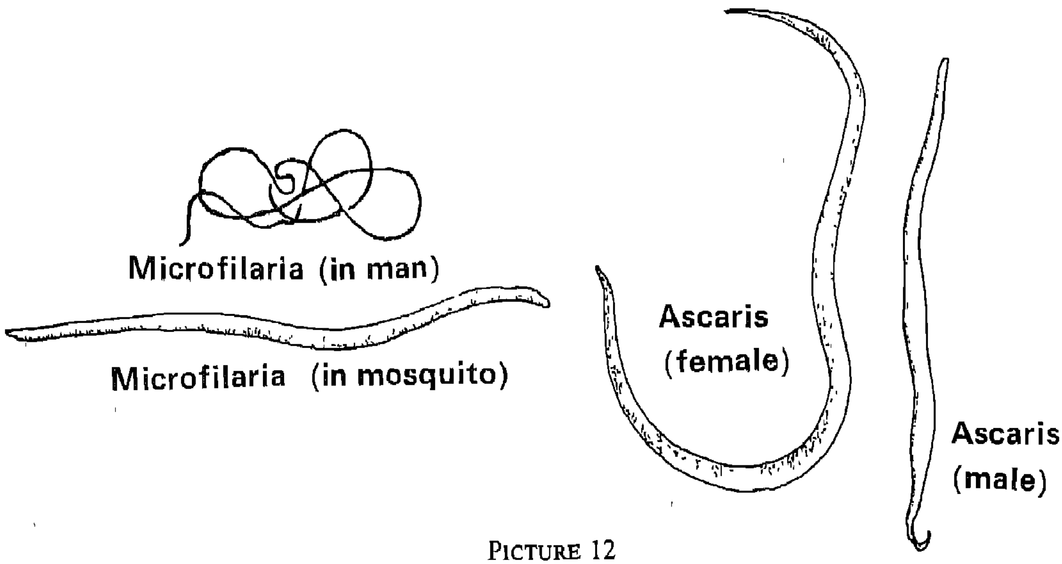


PICTURE 9

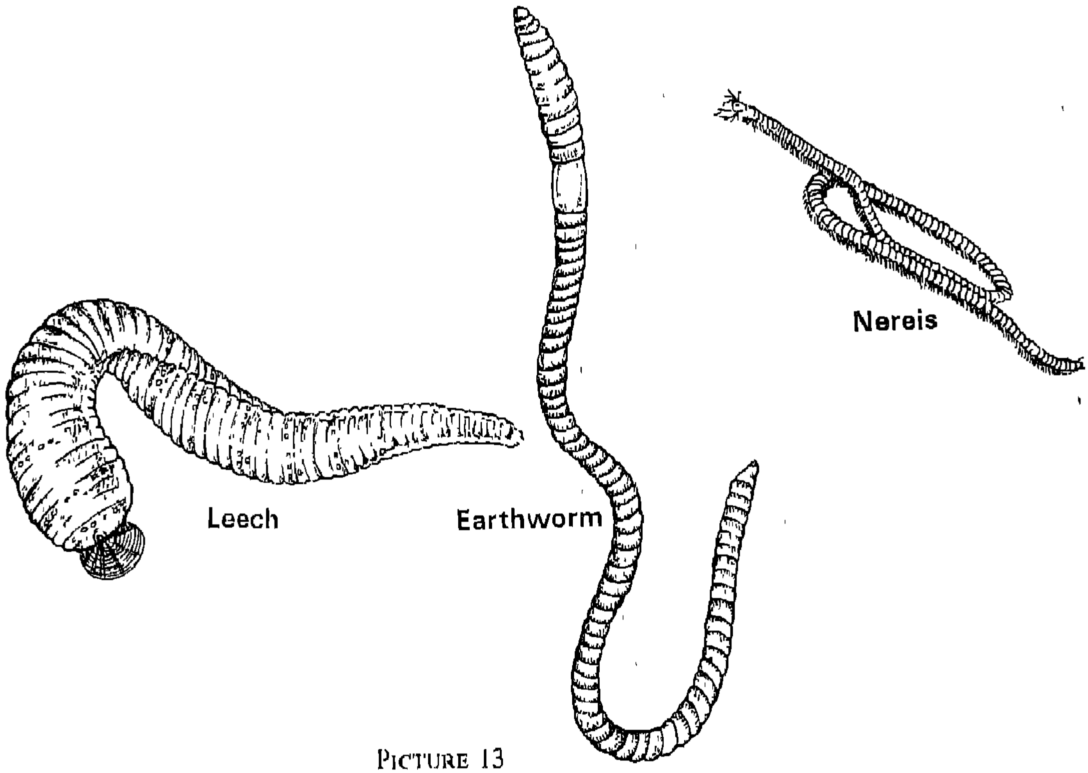


PICTURE 11

(1)	(2)	(3)	(4)	(5)	(6)
6	Plants with naked seeds	Gymnospermae (Spermatophyta)	Plant	Have flowers The size is medium to large Have seeds without any covering Have no true fruit	**Pines** **Cycas**
7.	Plants with seeds covered	Angiospermae (Spermatophyta)	Plant	Have flowers The seeds are enclosed within the fruit The size is small to very large	**Paddy plant** **Wheat plant** **Mango tree** **Coconut tree** **Banyan tree**
8.	Protozoa	Protozoa	Animal	Very tiny; cannot be seen with the naked eye The whole animal consists of one cell Move by the lashing of one or two whip-like bodies or of many hair-like bodies, or by sending out projections from the body Often live inside the body of other living objects	*Paramaecium*: Lives in ponds and pools; swims with the help of fine hair-like structures *Trypanosoma*: Causes the disease called sleeping sickness in man and birds; moves in the blood with the help of its whip-like part *Entamoeba*: Causes dysentery in man
9.	Sponges	Porifera		Are made of many cells; no head, eye, leg, etc. Have many pores on the body	*Spongilla*: A fresh-water sponge *Sycon*: The common marine sponge

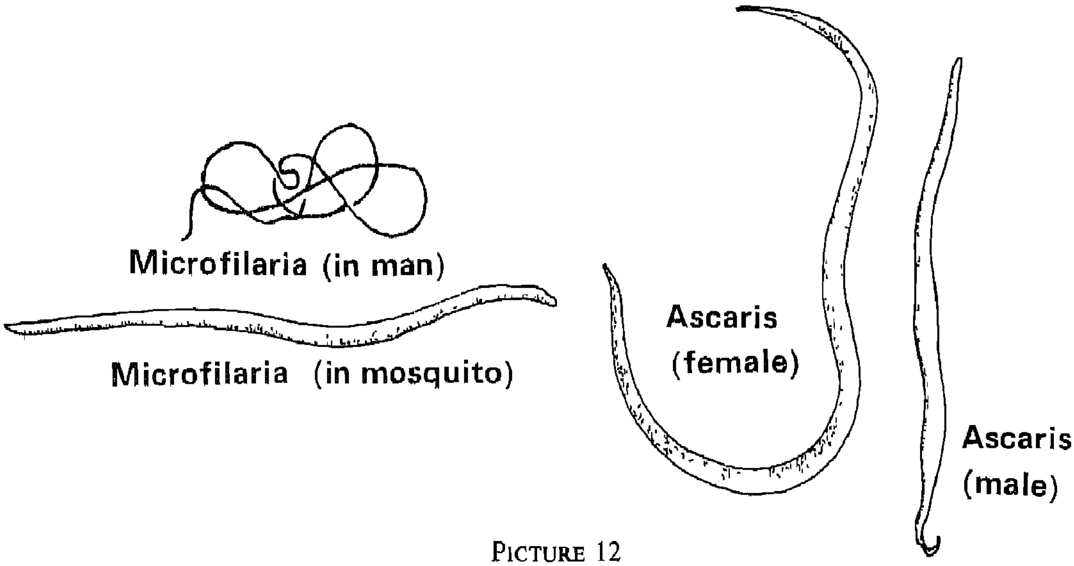


PICTURE 12

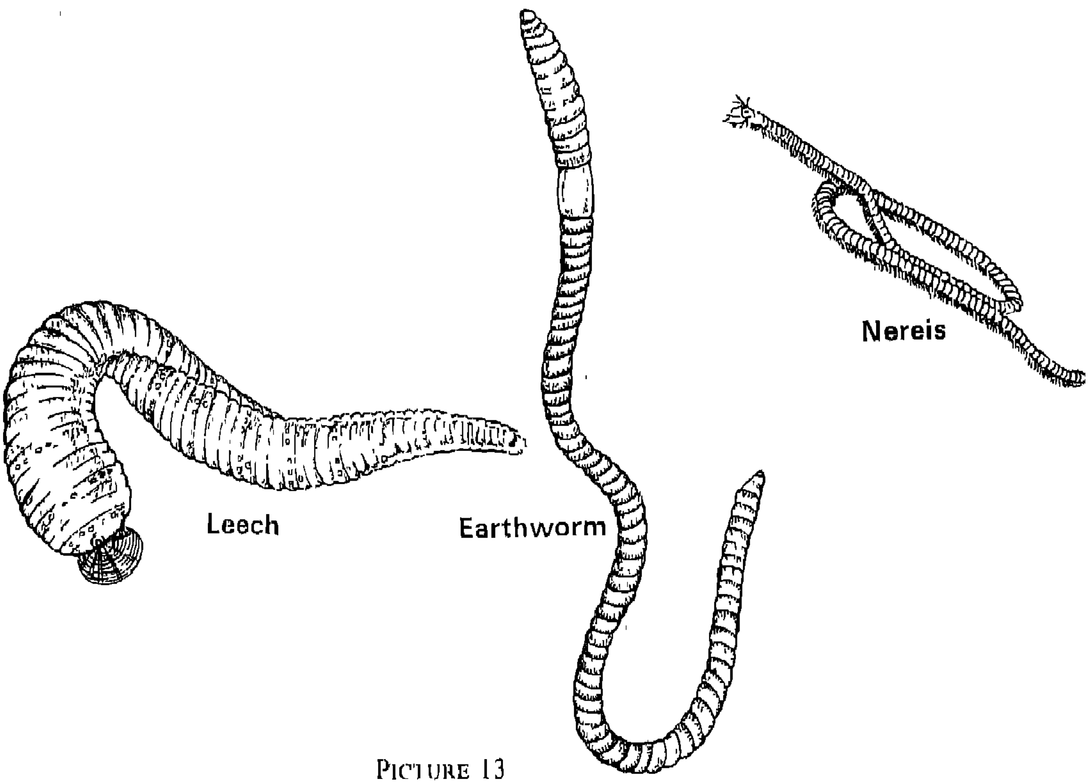


PICTURE 13

(1)	(2)	(3)	(4)	(5)	(6)
				Live attached to a solid surface under the water Live in colonies	
10.	Coelenterates	Coelenterata	Animal	Small in size The body has a single opening (the mouth), no anus Have tentacles Do not have head or legs The body-wall is made of only two layers of cells Live attached to a solid surface under water or swim freely	**Hydra**: Found in fresh water **Jellyfishes**: Body like an umbrella; swim in the sea **Sea anemones** Look like stalked flower, live attached to rocks under water or on the brink of the sea shore
11.	Flatworms	Platyhelminthes	Animal	Do not have regular head or legs The size is variable; some are small while others are very long The body is always flattened Look like a long ribbon or small leaves Live mostly inside the body of other organisms Cause disease in man and in other animals	**Tapeworms** Live as a parasite in the intestine of certain animals in which they cause disease **Liver flukes**: Leaf-like in appearance; live as a parasite in the liver of certain animals in which they cause disease. **Lung flukes**. Leaf-like in appearance, live as a parasite in the lung of



PICTURE 12



PICTURE 13

(1)	(2)	(3)	(4)	(5)	(6)
				Live attached to a solid surface under the water Live in colonies	
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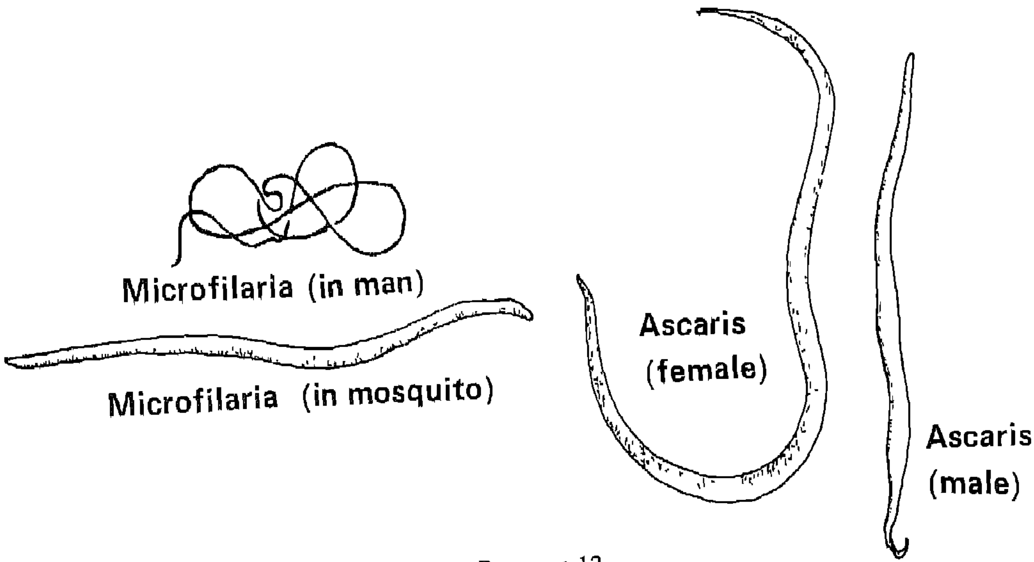

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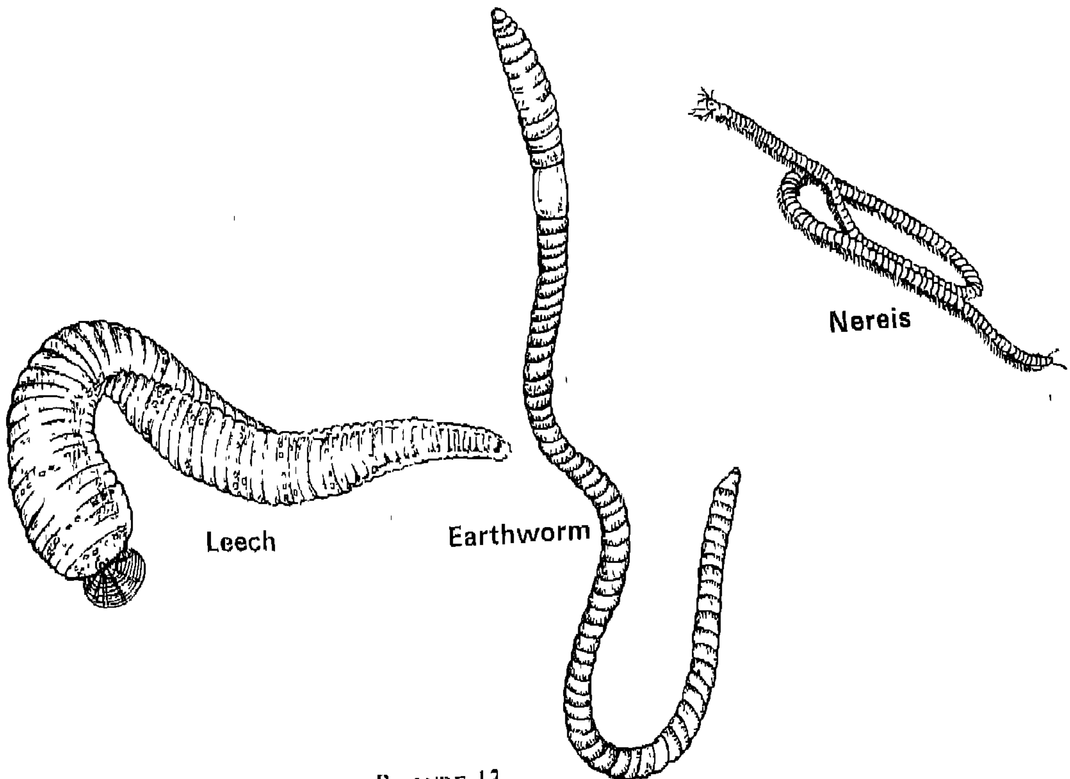

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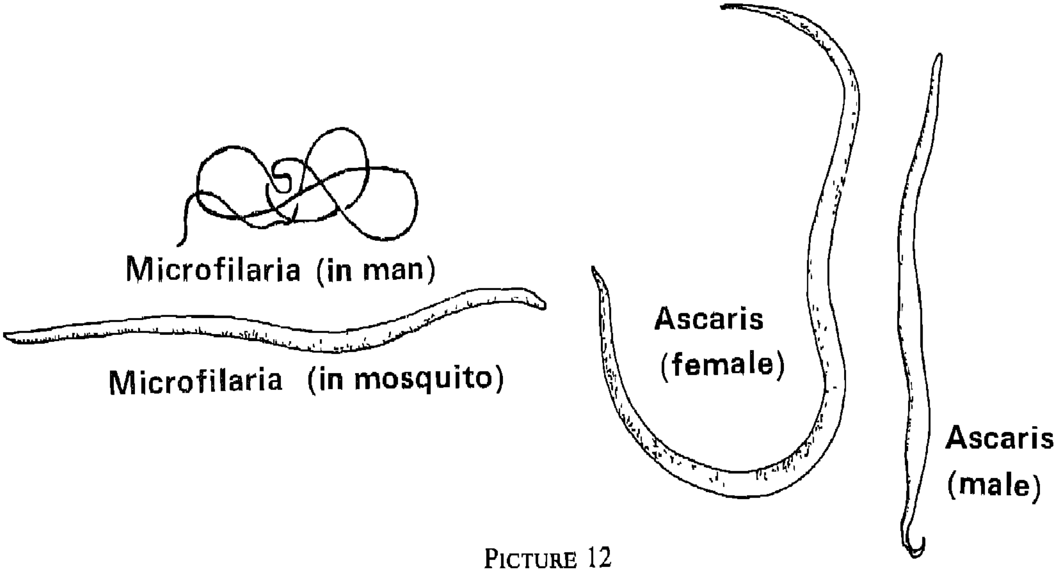

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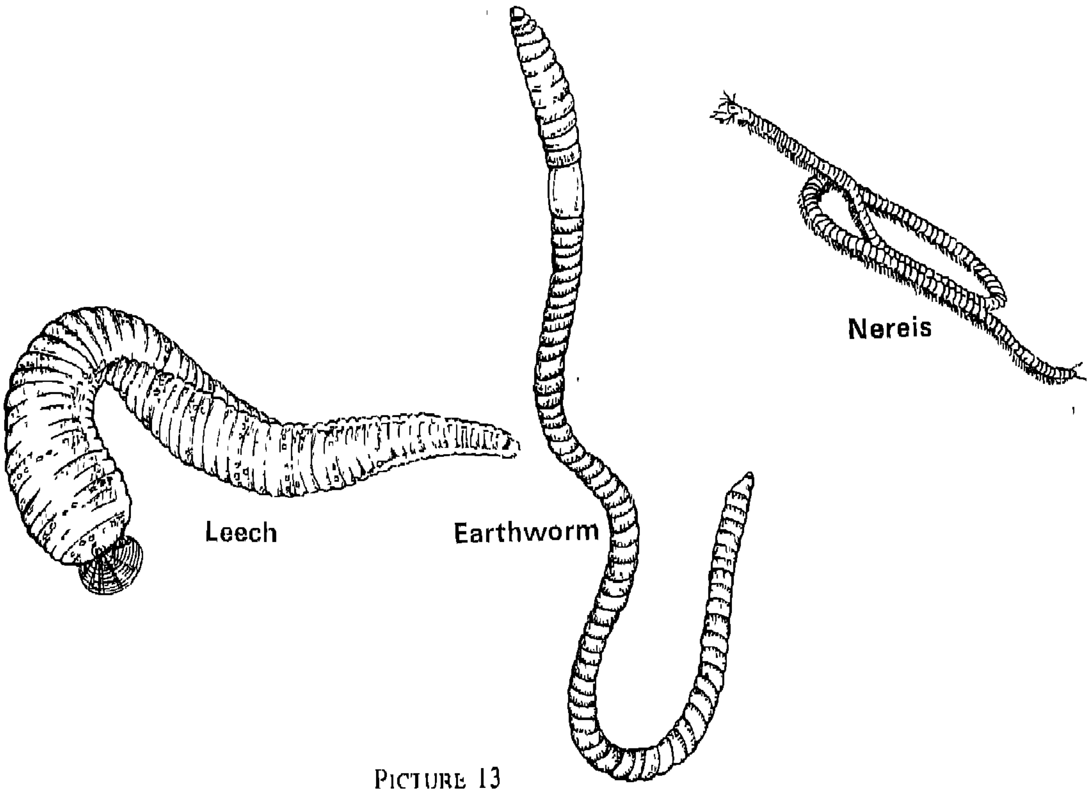

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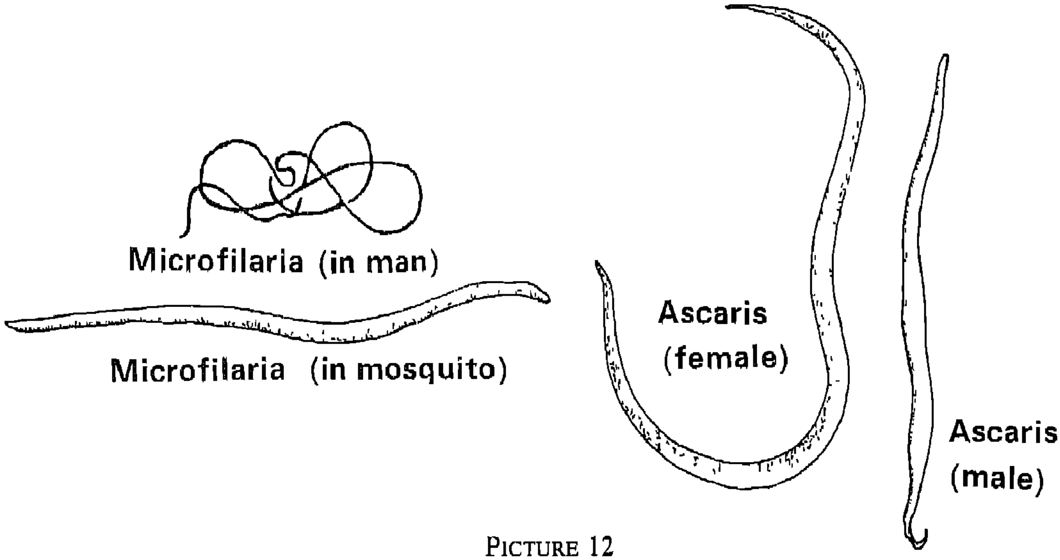
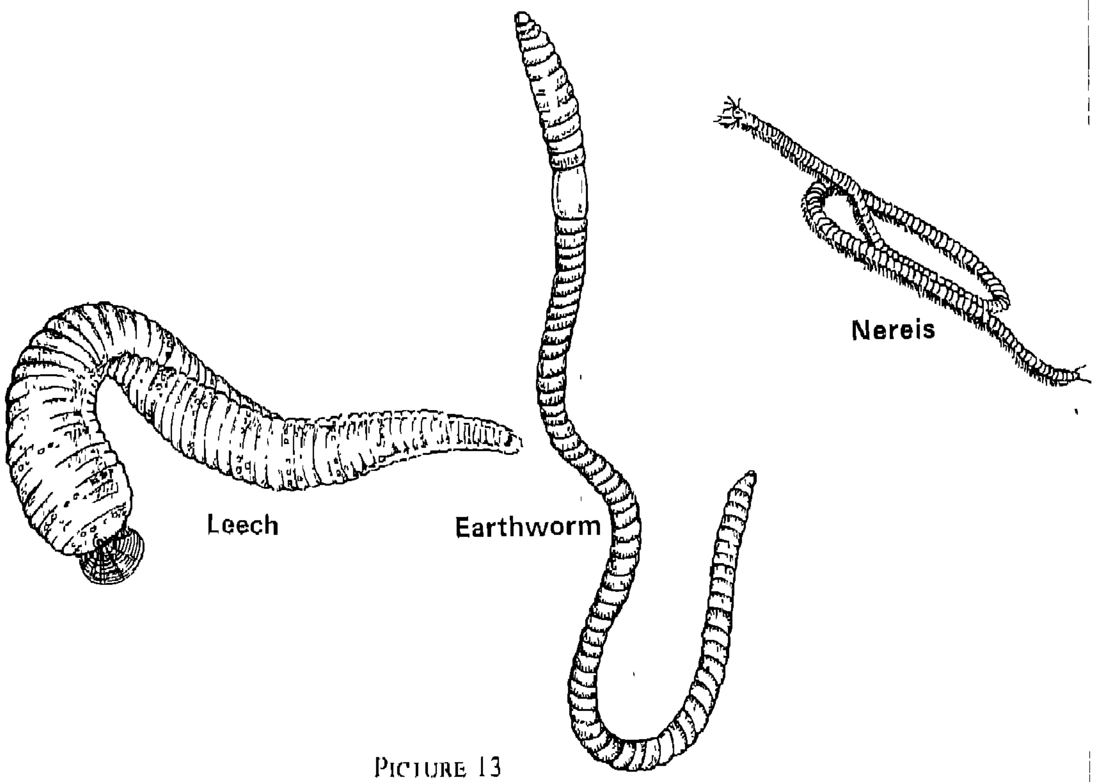


PICTURE 12



PICTURE 13

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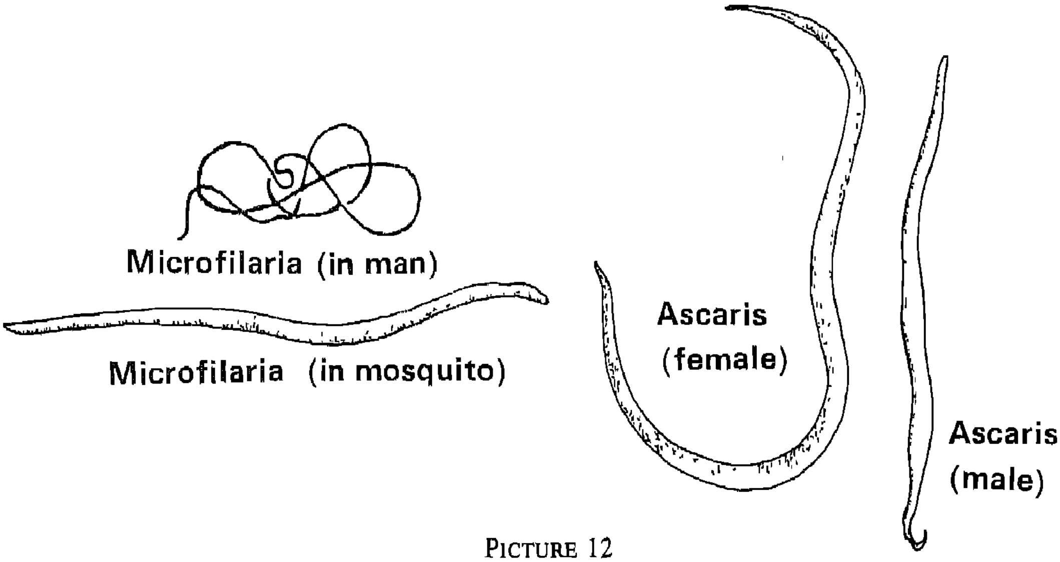
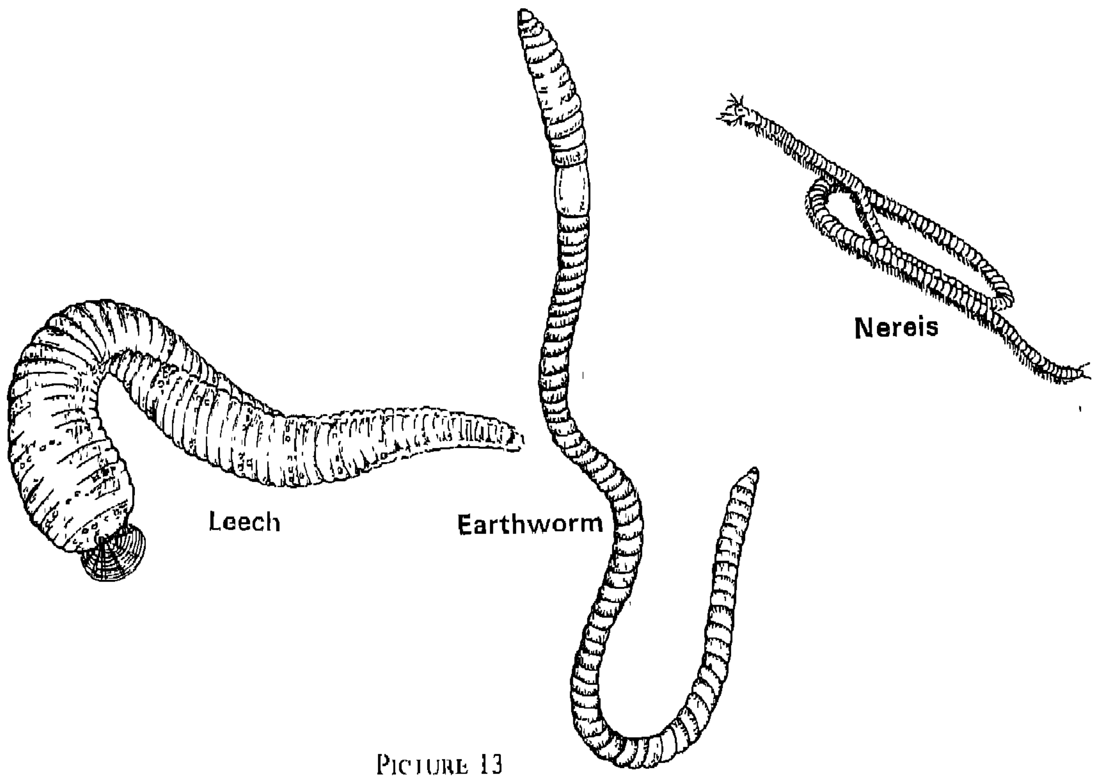


PICTURE 12



PICTURE 13

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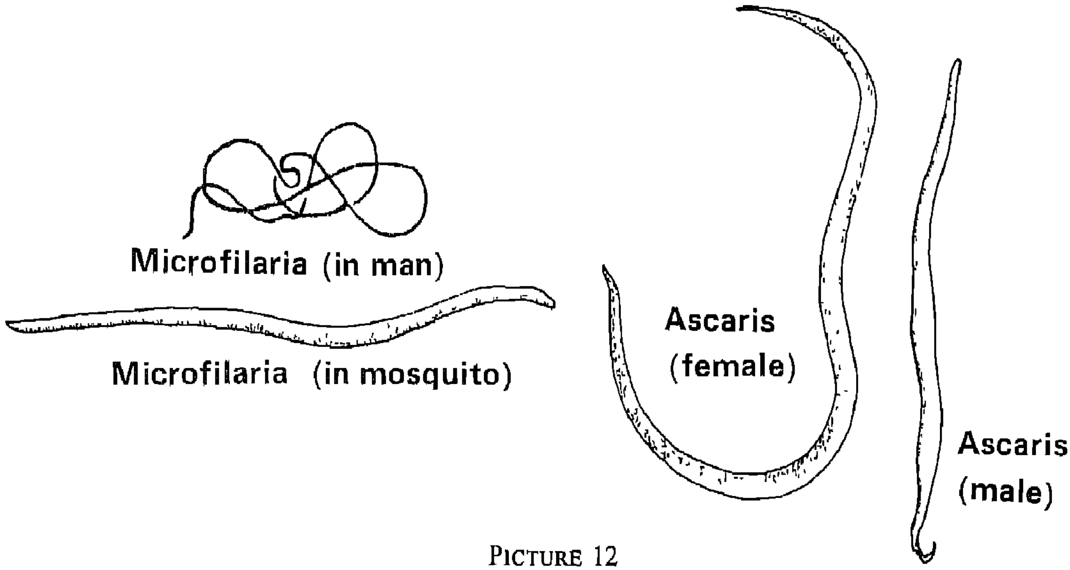

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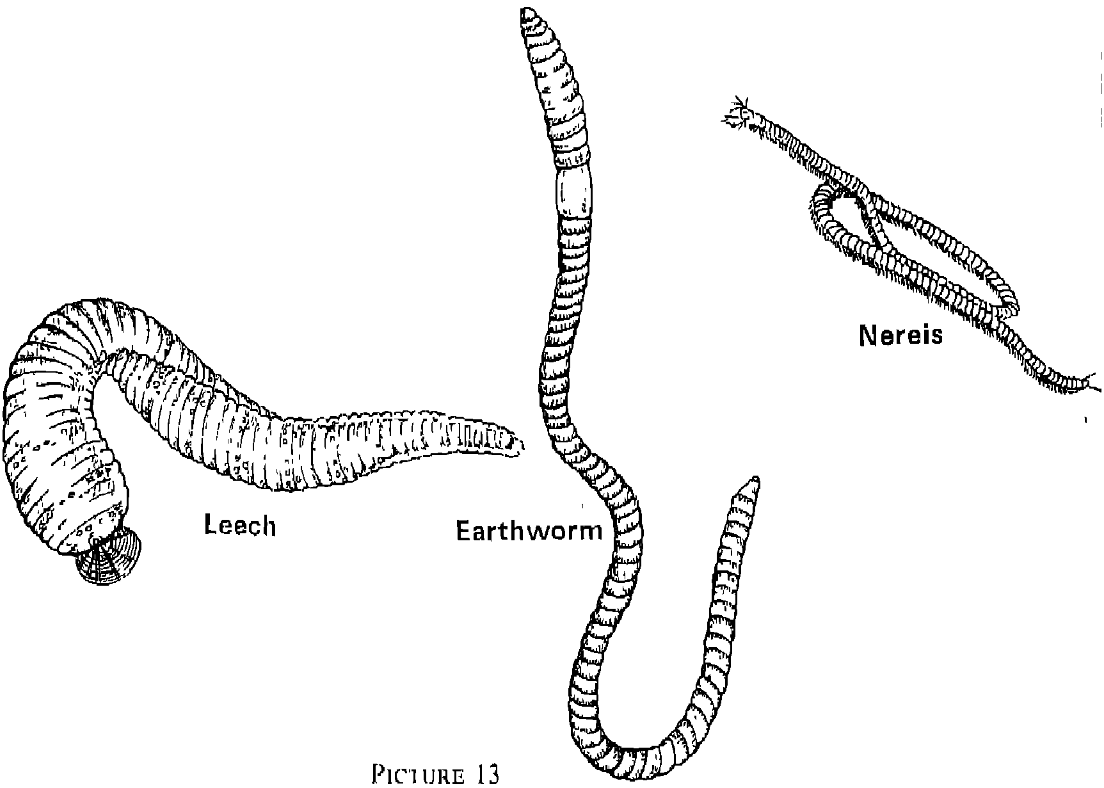

PICTURE 13

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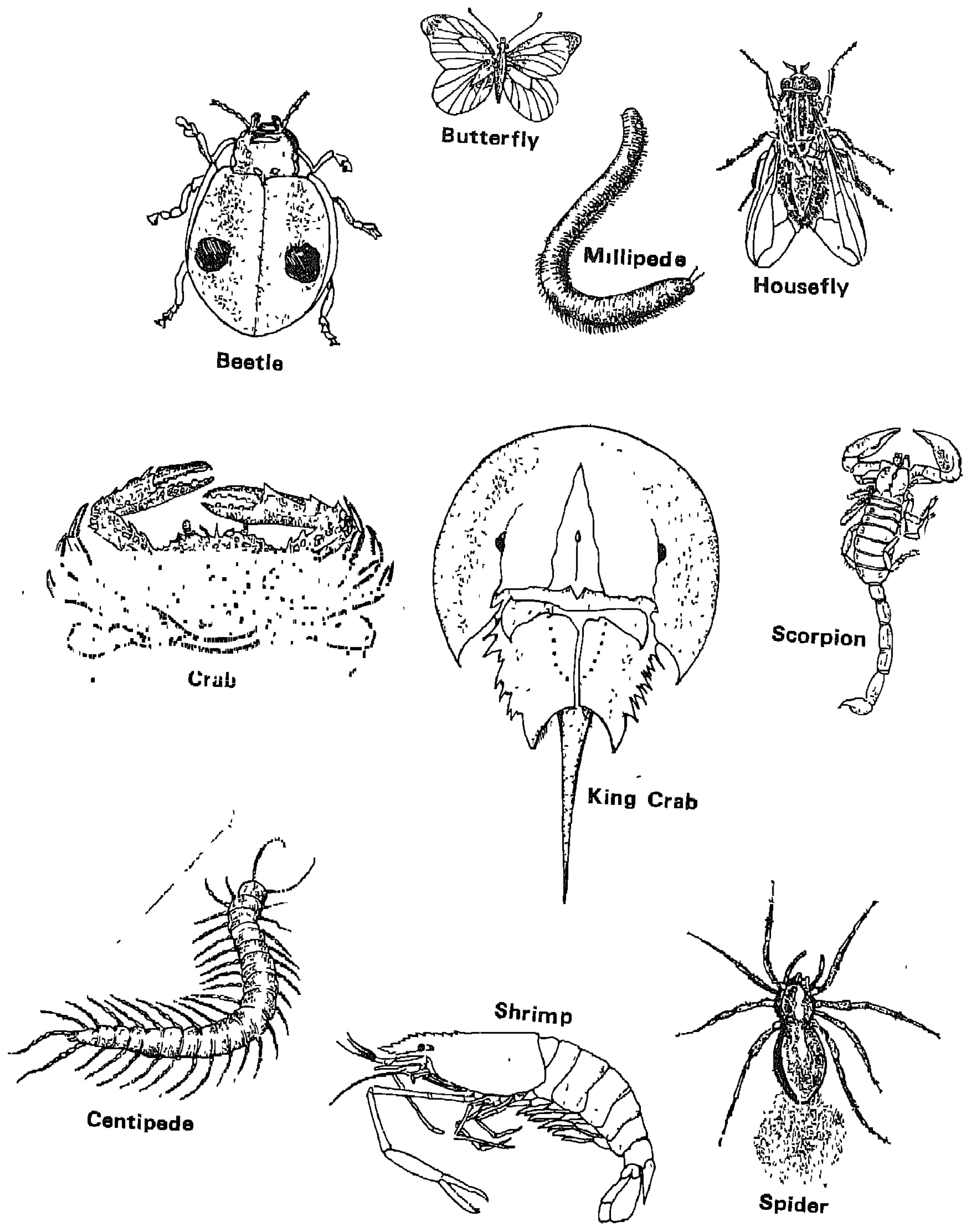
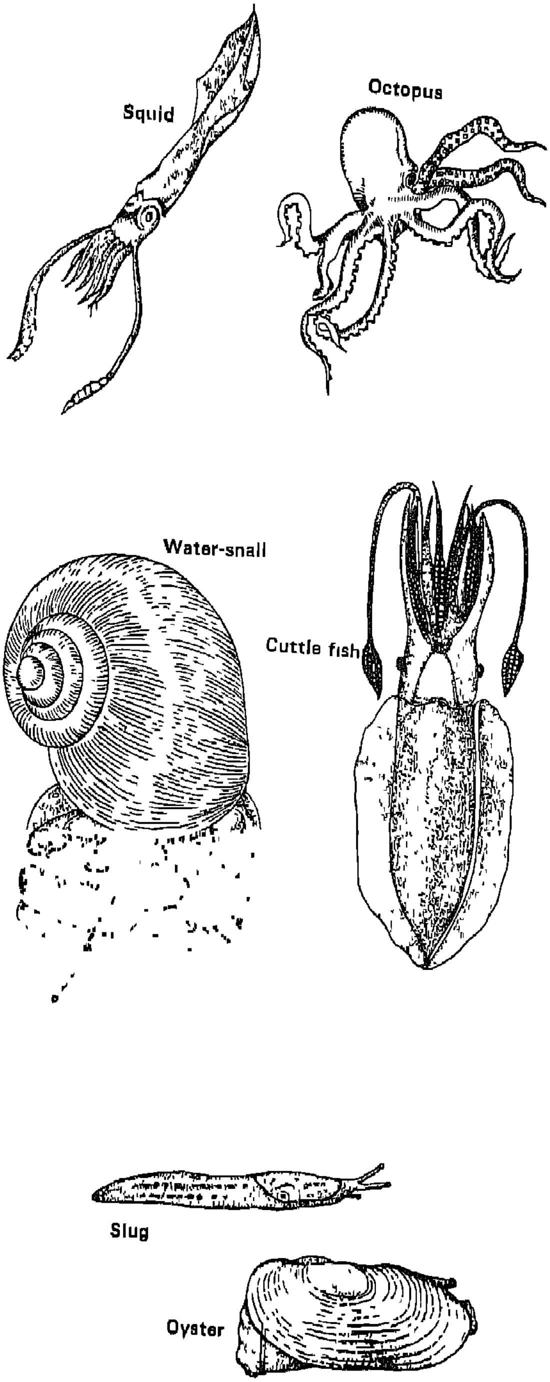
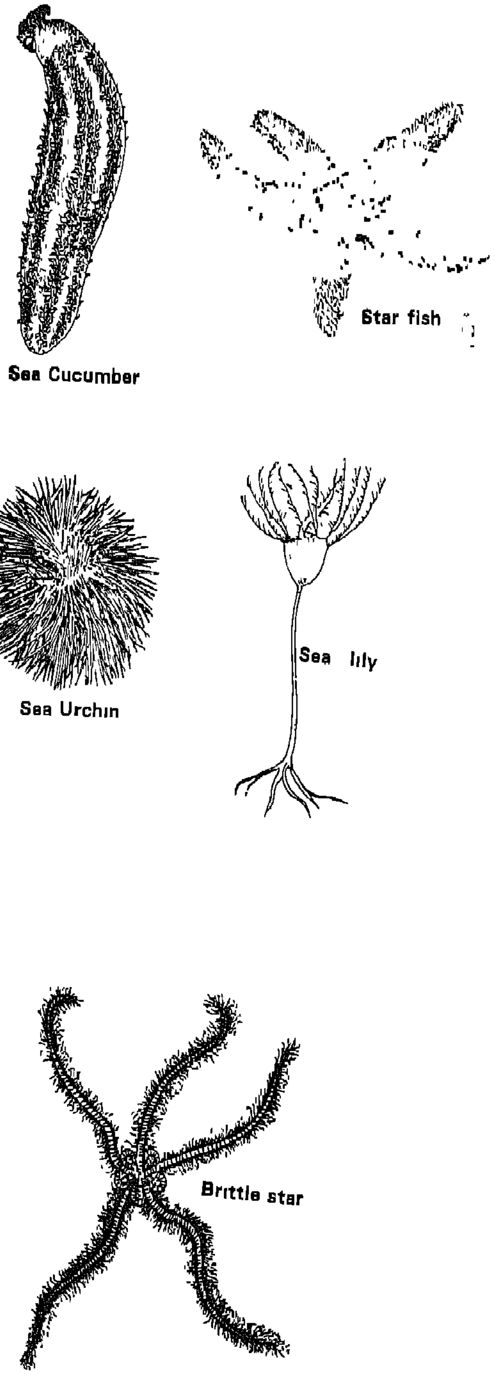

Butterfly
Housefly
Millipede
Beetle
Crab
King Crab
Scorpion
Shrimp
Centipede
Spider

PICTURE 14

(1)	(2)	(3)	(4)	(5)	(6)
					certain animals in which they cause disease *Planaria* Live in pond water
12.	Roundworms	Nematoda	Animal	Have an elongated, cylindrical body Do not have head or legs Have a mouth and an anus Live in water or soil, or inside the bodies of plants and animals Cause disease in plants and animals including man	*Ascaris*: Live as a parasite in human intestine; cause disease *Microphilaria* Live as a parasite in human blood or body ends; cause disease; spread by **Culex** mosquito
13	Segmented worms	Annelida	Animal	Have an elongated body that appears to be made of rings The body is internally divided into compartments The skin has a thin soft covering Legs, if present, do not have any joints (like elbow, wrist or finger joints)	**Earthworms**· Live in burrows in the soil **Leeches** Found in warm marshy places, suck blood of man, cattle etc. **Tube worms**: Live in burrows on the seashore. **Sea mouse**· Swims in the sea *Nereis*. Marine annalid with parts well formed for swimming.

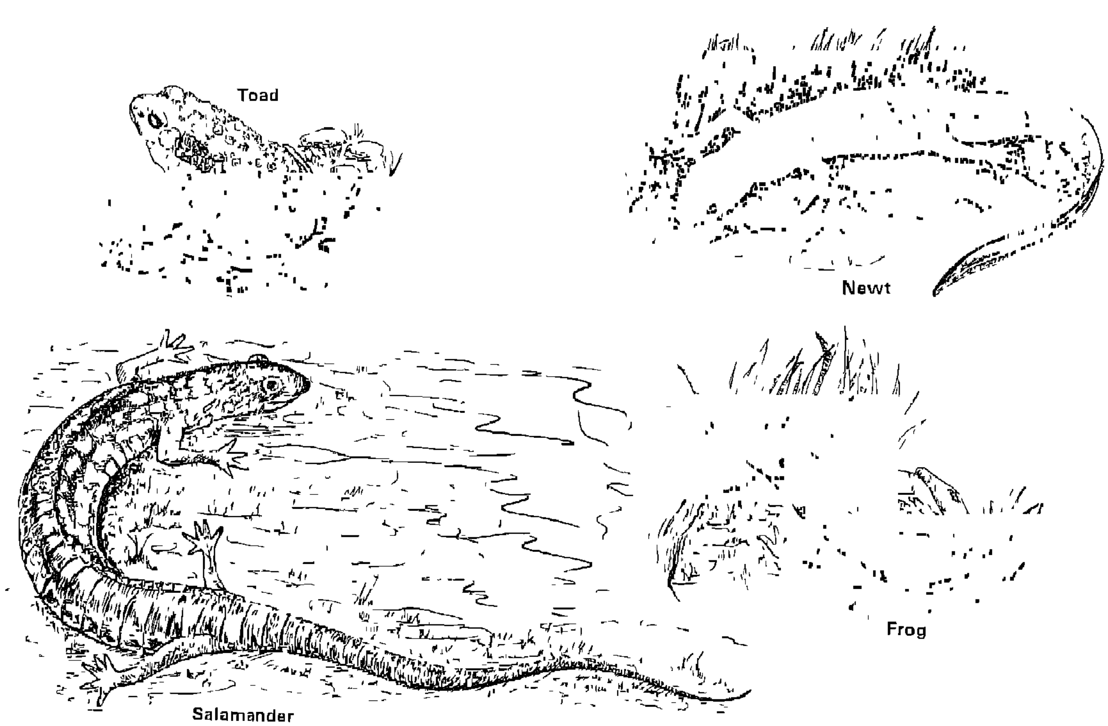


PICTURE 15

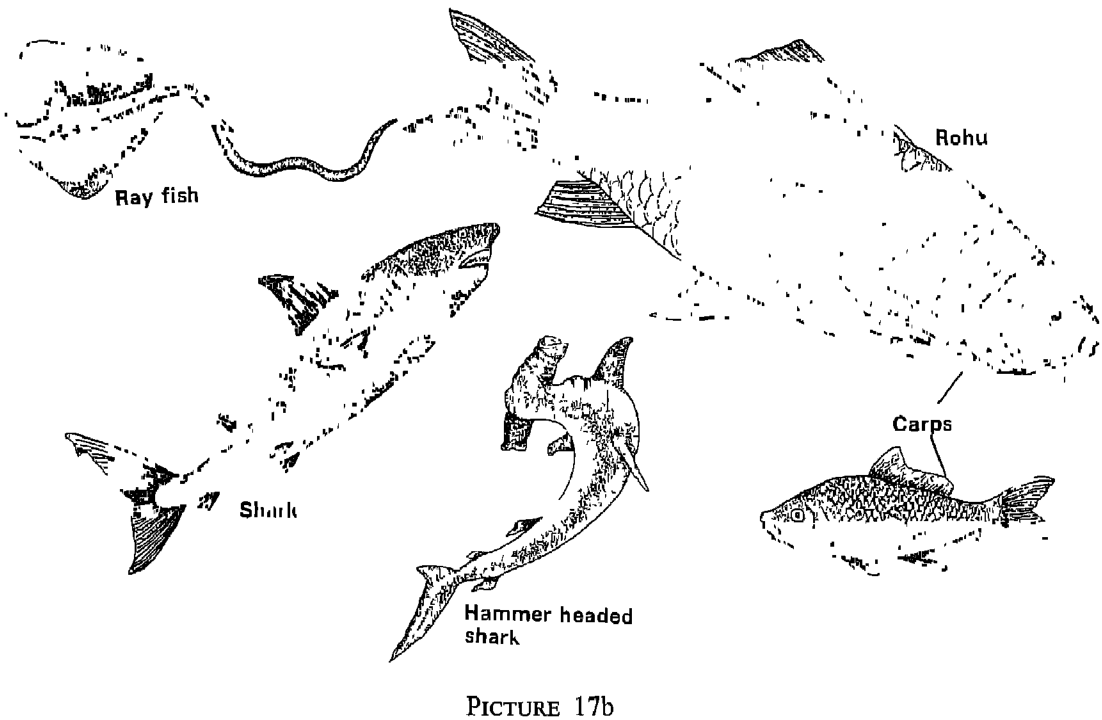


PICTURE 16

(1)	(2)	(3)	(4)	(5)	(6)
14.	Jointed-legged animals	Arthropoda	Animal	The body has head, breast (thorax) and belly (abdomen) The skin is covered with tough outer covering which consists of several pieces Have jointed legs (that is, the leg is made of several units) Live on land, or in ponds and sea, some can fly The size is very small to medium	**All insects such as flies, bugs, butterflies and beetles** **Crabs and shrimps** **Spiders** **Scorpions and king crabs** **Millipedes and centipedes**
15.	Shelled animals	Mollusca	Animal	Have a shell, outside or inside the body Have prominent muscular foot Have a head with tentacles Live on land or in water	**Slugs** **Snails** **Mussels** **Oysters** **Squids** **Octopus**
16.	Spiny-skinned animals	Echinodermata	Animal	The skin is covered with numerous spines The body has five star-like divisions Do not have a head Some live attached to surface; others live under sea water or on the shore	**Starfishes** **Brittle stars** **Sea urchins** **Sea cucumber** **Sea lilies**

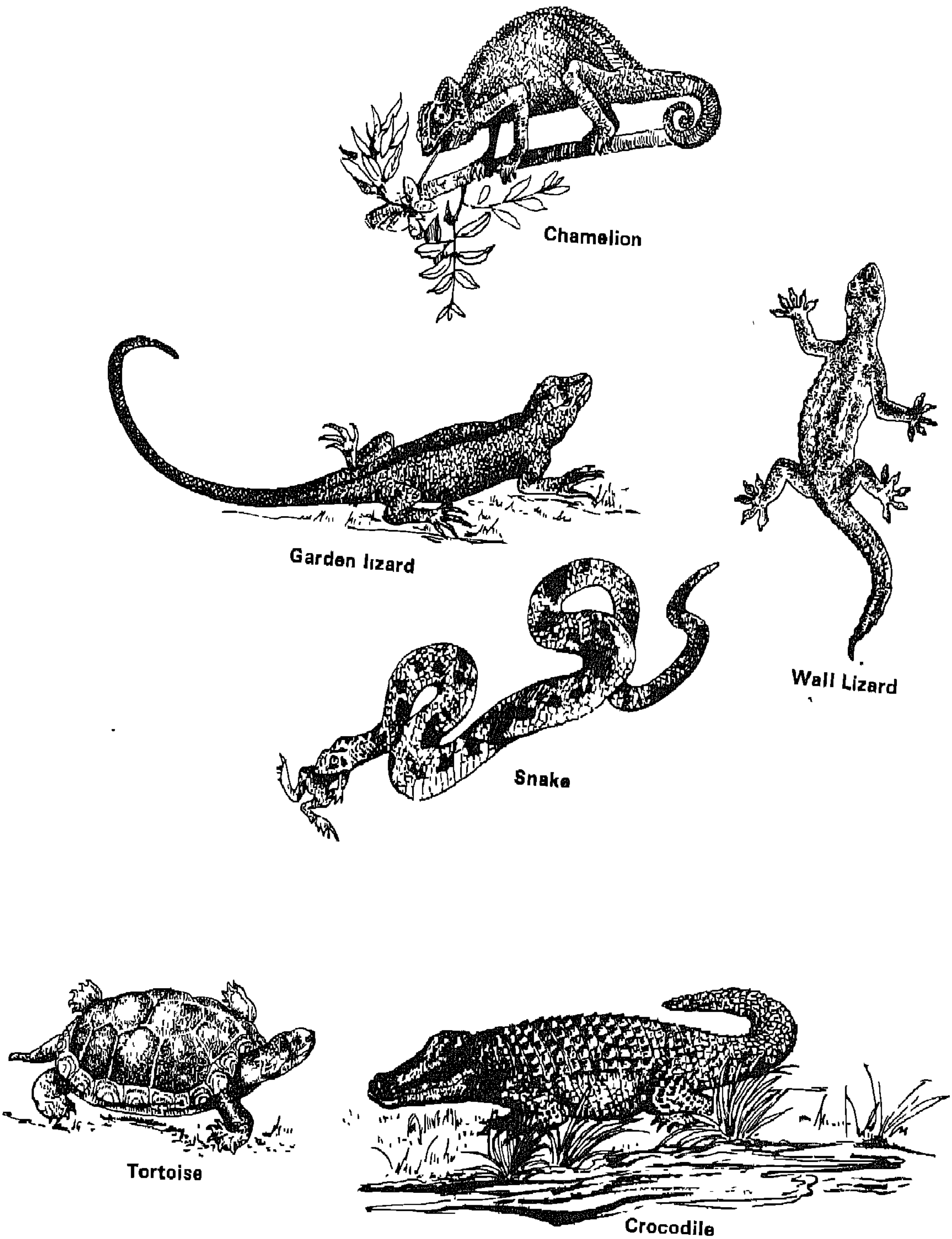


PICTURE 17a

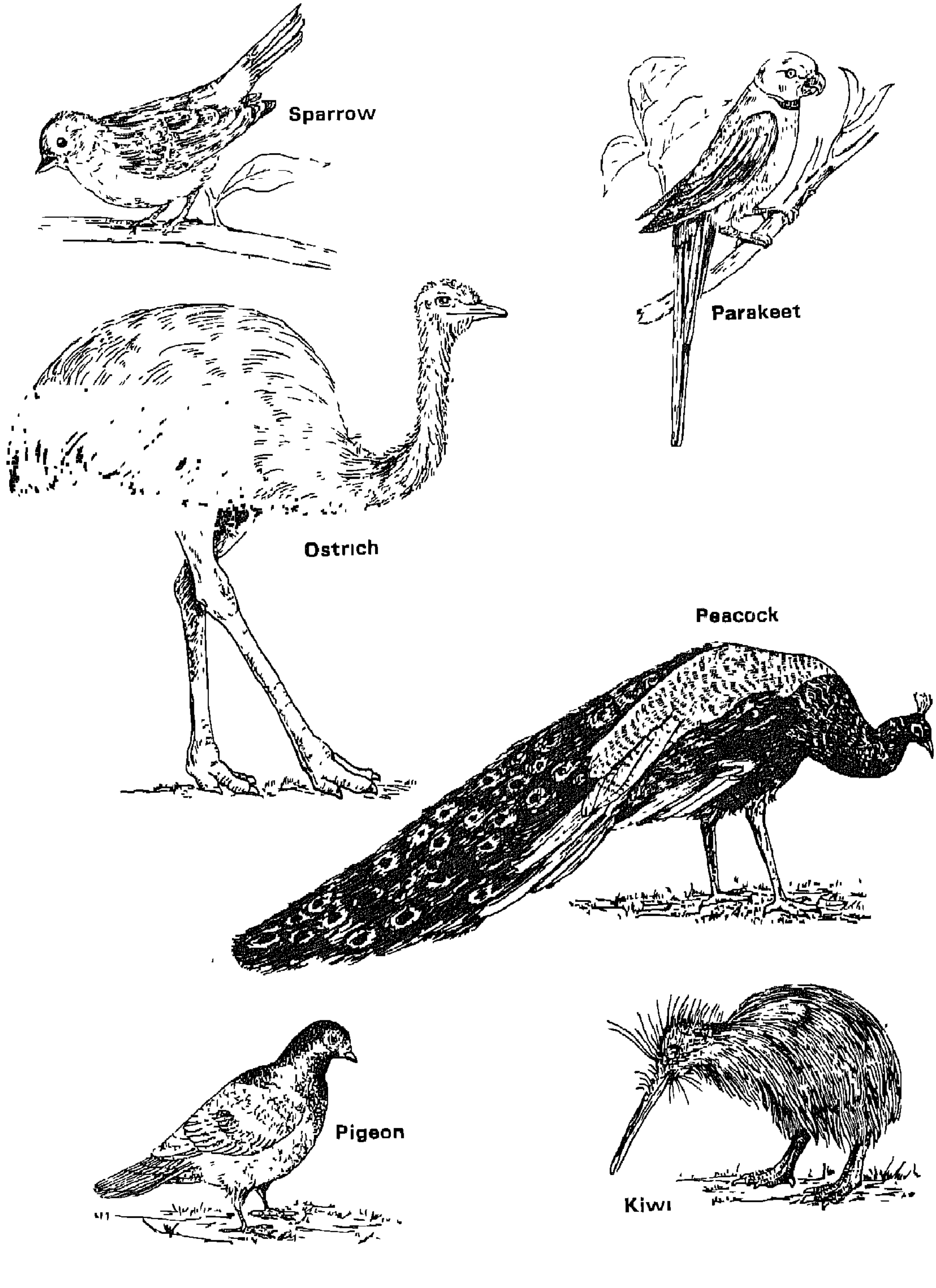


PICTURE 17b

(1)	(2)	(3)	(4)	(5)	(6)
17A.	Fishes	Pisces	Animal	**Have a backbone** The body usually has a distinct head, trunk and tail Have four or five gill openings Have paired fins with fin rays The skin is usually covered with 'scales'	**Sharks** **Rays** **Skates** **Carps**
17B.	Frogs and toads	Amphibia	Animal	**Have a backbone** The skin is naked, without any outer covering Have four legs Live both in water and on land, but lay eggs only in water	**Frogs, toads and tree frogs** (tailless amphibians) **Newts** **Salamanders**
17C	Reptiles	Reptilia	Animal	**Have a backbone** The skin is covered with dry scales Have paired legs with clawed fingers (excepting in a few cases) Have a tail	**Wall lizards** **Chameleons** **Garden lizards** **Snakes** (exception: legs absent) **Turtles and tortoises** **Crocodiles and alligators**
17D.	Birds	Aves	Animal	**Have a backbone** The skin is covered with feathers	**Ostrich** and **Kiwi** which cannot fly **Sparrow, Myna, Parrots,**

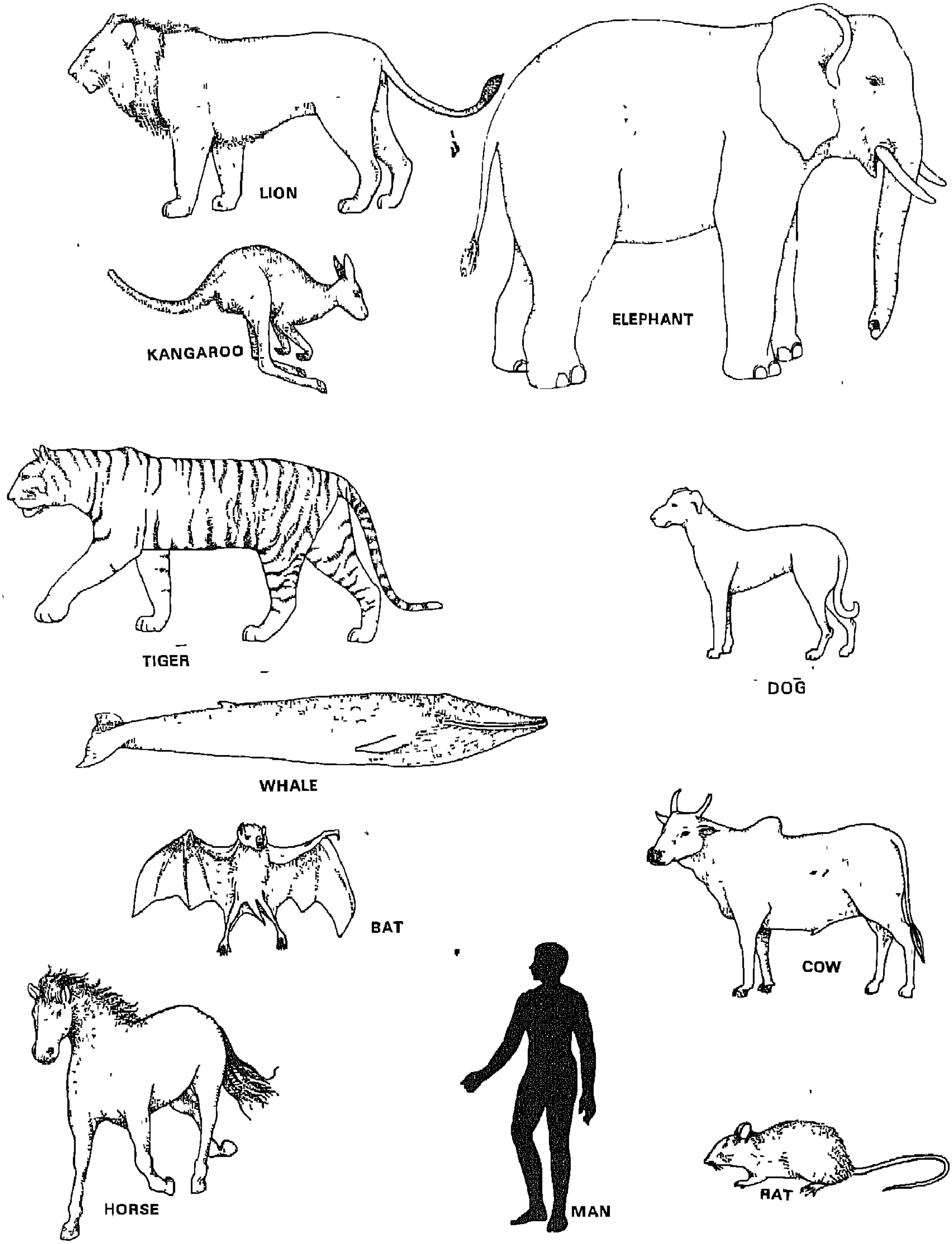

Chamelion
Garden lizard
Wall Lizard
Snake
Tortoise
Crocodile

PICTURE 17c



PICTURE 17d

	(2)	(3)	(4)	(5)	(6)
				Have beaks and no teeth Have two legs and two wings	**parakeets, pigeons** and **peafowls** which can fly **All other birds**
17E.	Mammals	Mammalia	Animal	**Have a backbone** The skin is covered with hair Have an external ear Feed their young with milk	Man, **apes and monkey** **Tigers, cats, dogs and lions** **Cattle, sheep and goat** **Rat and mouse** **Elephant** **Whale** **Kangaroo** **Bat**


LION
ELEPHANT
KANGAROO
TIGER
DOG
WHALE
BAT
COW
HORSE
MAN
RAT

PICTURE 17e

SET 2

SOME IMPORTANT FOOD-STUFFS, SPICES AND FLAVOURING AGENTS OF PLANT ORIGIN IN INDIA

Number	*Name of the food-stuff*		*Part(s) of the plant from which we obtain the food-stuff*
	English	*Hindi*	
(1)	(2)	(3)	(4)
1.	Pearl Millet	*Bajra*	Seed (Fruit)
2	Barley	*Jau*	Seed (Fruit)
3.	Sorghum	*Jowar*	Seed (Fruit)
4.	Maize	*Makka*	Seed (Fruit)
5.	Rice	*Chawal*	Seed (Fruit)
6	Wheat	*Gehun*	Seed (Fruit)
7.	Bengal gram	*Chana*	Seed
8	Black gram *dal*	*Urad ki dal*	Seed
9.	Green gram	*Moong*	Seed
10.	Lathyrus sativus	*Kesari dal*	Seed
11.	Lentil	*Masoor*	Seed
12.	Peas	*Mattar*	Seed
13.	French bean	*Rajmah ki phalli*	Seed
14.	Red gram	*Arhar ki dal*	Seed
15.	Soya bean	*Bhit*	Seed
16.	Amaranth	*Lal sag*	Root, stem and leaf
17.	Cabbage	*Bund gobhi*	Leaf
18.	Curry leaves	*Gandhela*	Leaf
19	Lettuce	*Salad*	Leaf
20.	Mint	*Pudina*	Leaf
21.	Mustard leaf	*Sarson ka sag*	Leaf
22.	Radish tops	*Muli ka sag*	Leaf
23.	Spinach	*Palak*	Stem and leaf
24.	Beet	*Chukander*	Root
25.	Carrot	*Gajar*	Root
26	Colocasia	*Arvi*	Stem
27	Onion	*Pyaz*	Stem and leaf
28.	Potato	*Alu*	Stem
29	Radish	*Muli*	Root

(1)	(2)	(3)	(4)
30	Sweet potato	*Shakarkandi*	Root
31.	Tapioca	Tapioca	Root
32	Turnip	*Shalgam*	Root
33.	Bitter gourd	*Karela*	Fruit
34.	Brinjal	*Baingan*	Fruit
35	Broad bean	*Sem*	Fruit
36	Calabash cucumber	*Lauki*	Fruit
37.	Cauliflower	*Phool Gobhi*	Flower
38.	Cucumber	*Kheera*	Fruit
39	Drumstick	*Sajne ki phali*	Fruit
40.	Giant chilli (Capsicum)	*Pahari Mirch*	Fruit
41.	—	*Kundroo*	Fruit
42.	Lady's finger	*Bhindi*	Fruit
43	Gooseberry	*Amla*	Fruit
44.	—	*Parwal*	Fruit
45.	Banana	*Kela*	Fruit
46.	Pumpkin	*Kaddu*	Fruit
47.	Ridge gourd	*Turai*	Fruit
48.	—	*Tinda*	Fruit
49.	Tomato	*Tamatar*	Fruit
50.	Water chestnut	*Singhara*	Fruit
51.	Almond	*Badam*	Seed
52	Cashewnut	*Kaju*	Seed
53	Coconut	*Nariyal*	Fruit
54.	Gingelly	*Til*	Seed
55.	Groundnut	*Moongphalli*	Fruit
56	Linseed	*Alsi*	Seed
57.	Mustard	*Sarson*	Seed
58.	Pistachio nuts	*Pista*	Seed
59.	Walnut	*Akhrot*	Seed
60.	Asafoetida	*Heeng*	Exudate
61.	Cardamom	*Illaichi*	Fruit with seeds
62.	Chilli	*Mirch*	Fruit
63	Clove	*Laung*	Flower
64.	Coriander	*Dhania*	Fruit

(1)	(2)	(3)	(4)
65	Cumin	*Zeera*	Seed
66.	Fenugreek	*Methi*	Seed
67.	Garlic	*Lehsun*	Stem and leaf
68.	Ginger	*Adrak*	Stem
69.	Mace	*Javitri*	Bark
70.	Nutmeg	*Jaiphal*	Fruit
71.	Celery	*Ajwain*	Seed
72.	Pepper	*Kalimirch*	Fruit
73.	Tamarind	*Imli*	Fruit
74.	Turmeric	*Haldi*	Root
75.	—	*Ambada*	Fruit
76.	Apple	*Seb*	Fruit
77.	Apricot	*Khubani*	Fruit
78.	—	*Bel*	Fruit
79.	—	*Ber*	Fruit
80.	Cherry	*Cherry*	Fruit
81	—	*Kamrakh*	Fruit
82	Date	*Khajur*	Fruit
83.	Fig	*Anjeer*	Inflorescence
84.	Grape	*Angoor*	Fruit
85.	Guava	*Amrood*	Fruit
86	Jackfruit	*Kathal*	Fruit
87	—	*Jamun*	Fruit
88.	Sweet lime	*Mausami*	Fruit
89.	Lemon	*Neebu*	Fruit
90.	—	*Lichi*	Fruit
91.	Mango	*Aam*	Fruit
92	Watermelon	*Tarbooz*	Fruit
93.	Melon	*Kharbooza*	Fruit
94.	Orange	*Santara*	Fruit
95.	Palmyra fruit	*Tarh*	Seed
96.	Papaya	*Papita*	Fruit
97.	Peach	*Arhu*	Fruit
98.	Pear	*Nashpati*	Fruit
99.	—	*Phalsa*	Fruit
100.	Pineapple	*Ananas*	Fruit
101.	Plum (red)	*Alubukhara*	Fruit
102.	Pomegranate	*Anar*	Fruit

(1)	(2)	(3)	(4)
103.	Homelo	*Chakotra*	Fruit
104.	Custard apple	*Sharifa (Sitaphal, Atafal)*	Fruit
105.	Wood apple	*Kaitha*	Fruit
106.	—	*Ansfal*	Fruit

GLOSSARY

Almanac: A register of days, weeks and months of the year. It contains information about the time of sunrise, sunset, moon rise, planetary positions and schedule of important festivals. Almanac is more commonly known as *Panchang*.

Amino acids: Chemical compounds which serve as fundamental constitutent units of proteins in a living body. Many amino acids are known to occur in nature and many more can be made in the laboratory, but only 20 are found in proteins Proteins are made from the amino acids in the same way as a necklace may be made from a set of different coloured beads

Appendix: This is a tube-like prolongation of the large intestine of the food tube. In cattle, rabbit and guineapig, the appendix is large and functional, but in man, it is a small and functionless structure. Infection in this structure causes a disease called appendicitis.

Armadillo: A toothless mammal, the body of which is covered by hard plates; found in South America.

Aryabhata. A great Indian astronomer of the 5th century. The first Indian artificial satellite was named after him.

Atom: The smallest part of an element that can participate in a chemical reaction.

Bacteria. Minute organisms, present in air, soil and water. Some of them produce disease, others help in decomposing plant and animal materials

Bleaching powder: Also known as chloride of lime, it is used for bleaching and as a disinfectant.

Bud: The undeveloped stage of a shoot in higher plants that later develops into leaves, branches or flowers.

In some lower plants and animals, the buds develop from the body of the organism and finally detach to form a new organism.

Cell: 1. A minute structure: It is like a room with its walls It is the structural unit of all organisms.

2. A device for producing electric current by chemical action.

Carbohydrates A group of organic compounds found in living organisms. Carbohydrates are composed of carbon, hydrogen and oxygen, the latter two being in the same proportion as water.

Centrifugation: The process by which particles are separated from a suspension by swirling. This process is usually carried out in an apparatus, called the centrifuge.

Chromatography: A method which separates the components of a mixture by making use of their different liking for another substance.

Cholera. A highly infectious disease in which frequent vomiting and purging occur

Citric acid An acid present in large amounts (6%) in lemons and many other sour fruits. It is used in drinks to make them sour.

Comet: A heavenly body which moves under the attraction of the sun. It receives all its light from the sun It appears to have a bright central portion and a tail directed away from the sun.

Compound· A substance formed by the chemical union of two or more elements in definite proportions by weight

Condensation: A physical change in which the gaseous form of a substance is converted into its liquid form.

Constellation: A group of stars forming a pattern which does not change when the stars move.

Crowbar: A large iron rod bent at the end like the beak of a crow.

Crystallization: Solidification of a substance into a definite geometrical form

Dam: A high structure constructed to hold a large amount of water to prevent it from spreading.

Decantation: The process of separation of an insoluble solid from a liquid by allowing the former to settle and then pouring off the latter

Dinosaurs A group of extinct reptiles, including many giant forms, who lived 120-180 million years ago on the earth

Distillation The process of boiling a liquid to produce vapour and then condensing the vapour back into the liquid in order to separate it from a mixture

Earthlight: The light reflected from the surface of the earth.

Eclipse. The passage of a non-luminous body into the shadow of another.

Element· A substance made up of atoms of one type

Energy. The capacity to do work. There are many forms of energy such as potential, kinetic, electrical, heat, chemical, nuclear and radiant. They are all interconvertible

Evaporation. The conversion of a liquid into vapour, without necessarily reaching the boiling point of the liquid

Evolution· It is the act or process of gradual development. The "theory of evolution" states that all living objects (including man) developed, and are still developing, by gradual and continuous change from simpler forms

Explosive. A material which, by rapid chemical reaction, releases large amounts of energy in a rapid burst.

Fertiliser· Chemicals used to give back to the soil nutrients lost from it by intensive cultivation

Filter. A device that separates a liquid from a solid when their mixture is passed through it.

Force An agent which either changes the motion of a body or deforms it

Friction The resistance offered to motion by contact between surfaces

Fuel· Any material, the burning of which produces energy in a form that can be used conveniently Coal and petrol are two commonly used fuels.

Fulcrum: The fixed point about which a lever can move.

Gas· A state of matter in which the molecules move freely in all directions. A gas has no fixed volume or shape.

Germ· Any micro-organism (such as a bacterium or a virus), specially a harmful one, which causes disease.

Germination The early stages of the growth of a seed or a spore. During these stages, the seed or the spore moves from the state of arrested growth into the state of active growth.

Gravitation· The property of all material bodies to attract and be attracted to each other

Great Bear A constellation in the northern sky Its seven bright stars are known as the plough It is also called **Ursa Major** or *Saptarishi.*

Hejira or Hegira· Mohammed's flight from Mecca to Medina (622 A.D), taken as the first year of the Muslim calendar Hejira calendar is a lunar calendar

Hibernation: The state of reduced activity in which certain "cold blooded" animals (like the frog) can live without food for long periods — often for many months Such animals often go into this state during the winter months

Jupiter The largest planet of our solar system It is the fifth planet from the sun.

Kilogram. A commonly used standard unit of mass or weight. Its prototype is preserved in Paris

King cobra. A species of poisonous snakes related to the Cobra It often exceeds 4-5 m in length and lives on other snakes

Kingfisher· A family of birds which feed on fishes They have a brilliant colourful plumage.

Lasers· A device for the production of light rays of high intensity which do not diverge. A laser light beam can, therefore, be focussed on a very small area over a very large distance It may prove to be an efficient means of communication over interplanetary distances.

Leaflets: Units of a compound leaf arranged on a common stalk. Leaflets do not have buds at their bases

Leap year· Every fourth year of Gregorian calendar divisible by four (excluding

centesimal years not exactly divisible by 400) A leap year has 366 days, a day being increased during the month of February which, therefore, has 29 days in the leap year

Lever: A rigid bar which may be turned freely about a fixed point of support, called the fulcrum It is a simple machine

Liquid: A state of matter in which the molecules can move more freely than in solids but less freely than in gases Liquids have no definite shape but they do have a definite volume.

Lubrication: The process of applying grease or oil whereby the friction between two surfaces is reduced.

Lunar calendar The system of counting days, months, years and seasons, based on the moon's revolutions around the earth.

Machine: A device for overcoming resistance at one point by the application of a force, usually at some other point

Manure: Any material used for improving the fertility of soil, especially for farming purposes. Decayed remains of living objects — specially plants — make a good manure. Fertilisers are chemical manure.

Mercury. 1 The smallest planet of our solar system It is the planet nearest to the sun.

2 A very heavy, silvery element, liquid at room temperatures, extensively used in thermometers

Metre The standard unit of length in the metric system.

Microscope· An optical instrument that gives a magnified image of a minute object by using one or a combination of lenses

Mineral Any substance that occurs naturally on the earth.

Mixture· Two or more substances occurring together in a way that they can be separated by physical or mechanical means. None of the components in a mixture undergoes a chemical change as a result of being "mixed". The proportion of the components in a mixture can vary.

MKS system· A system of units in which the unit of length is metre, that of mass is kilogram and that of time is second

Molecule: The smallest particle of a substance (that is, of an element or a compound) capable of independent existence under normal conditions, while retaining its properties.

Motion: The change of the position of a body in relation to another.

Nutrients· Constituents of food which a living organism can use to maintain itself or to grow.

Nutrition: Receiving food for growth or maintenance.

Nylon· A kind of fibre made by man. It is not found in nature

Oscillation The phenomenon of swinging to and fro like a pendulum.

Pendulum· A weight hung from a fixed point

in such a way that it can swing freely.

Penicillin: A chemical substance, that can kill many types of bacterium It is produced by certain moulds called **Penicillia**. It is used very widely as a medicine The discovery of penicillin was one of the most important discoveries in medicine.

Planet· A heavenly body revolving in a definite orbit around a star

Pole star: A star which always appears in the direction of the north pole. It is frequently used for finding direction during the night.

Pollution. Making dirty or unclean. Pollution of environment means releasing materials into air, land or water that would harm living organisms.

Pressure. The force per unit area acting on a surface.

Proteins. Large molecules made up of a number of amino acids (see amino acids). Apart from water, proteins are the single largest constitu- of living objects.

Pulley· A simple machine consisting of a small wheel fixed on an axle.

Radiation· The emission of a form of energy (such as heat or light) by an object Radiation cannot normally be seen, but it can often be felt or detected at a distance.

Reaction: A consequence of one object acting on another A chemical reaction involves a chemical change

Refineries. Factories where certain substances, such as sugar or oil, are prepared in a pure form from a crude form

Reproduction· The way by which living things continue their own species by the production of new individuals

Rubber. A stretchable and elastic product made from a liquid material (the *latex*) which oozes out of certain trees after a cut is made in their bark.

Saffron The powdered, dried stigmas of the plant *Crocus Sativus* Saffron has been used to colour and flavour food from very early times

Satellites: Heavenly bodies revolving round a planet

Saturn. A prominent planet of our solar system with nine satellites and a set of rings which go round its body

Scaly ant-eaters Toothless mammals which have their body covered by flattened 'scales' (modified hair) and scanty hair. They live on ants and termites.

Screw: A simple machine, cylindrical in appearance with a helical groove or ridge.

Shooting stars Short-lived streaks of light visible in the sky on a clear night They are caused due to melting and evaporation of small heavenly objects entering the earth's atmosphere.

Smallpox. A nasty infectious disease caused by a virus. It causes fever followed by a rash.

Solder A substance used to join pieces of metal or metallic objects. Solders are often a mixture of tin and lead or of copper and zinc.

Solar calendar: The system of counting days, months, years and seasons, based on the time taken for one revolution of the earth around the sun

Solid: A state of matter in which it has a definite shape, size and volume

Speed: Ratio of the distance moved to the time taken by a moving body

Spinning motion: A type of motion in which the object does not change its position but every point on the object continuously changes its position with respect to a fixed axis. The distance of a particular point ~m the axis, however, remains ~hanged.

~l scale A widely used common

~ie star nearest to our planet, earth It ~ie main source of energy we use.

A dark, viscous mixture obtained on ~ating materials such as wood, coal etc. ~s composition varies according to its source.

~perature: A measure of the 'hotness' of ~n object.

~ides: The regular rise and fall in the level of the sea caused by the pull of the moon and, to a lesser extent, of the sun.

Tractor. A motor vehicle used for working ploughs and other agricultural tools

Translational motion. A type of motion in which the moving object changes its position

Transistor: A small device made from a chemical called germanium. It can regulate the flow of electric current and is widely used in electrical gadgets and instruments such as the radio, the television, etc.

Tuberculosis: An infectious disease caused by the germ, *Mycobacterium tuberculosis* It often affects lungs.

Turn table: A circular, revolving platform often used for turning objects, such as a railway engine around.

Typhoid: An infectious disease caused by the germ *Salmonella typhi*.

Universe. The sum total of existing matter, energy and space including the heavenly bodies.

Uranus. The seventh planet of our solar system. It has five satellites

Vaccine: A preparation containing killed germs When it is introduced into living systems, it leads to the formation of antibodies which help **fight** later infections by the living forms of the same germ.

Vegetative propagation. A type of reproduction (observed only in plants) in which part of an organism gives rise to the whole. No reproductive cells are required for this kind of reproduction

Venus: The second planet of our solar system.

Vibrational motion: A type of motion in which the object does not move but changes its size or shape during the motion.

Viking I. The American spaceship for probing the planet, Mars. A part of Viking I, the Viking I lander, landed successfully on the Mars on 20th July 1976.

Viruses: Very, very small organisms responsible for many diseases They can be seen only through special types of microscopes They behave like living objects inside a living cell but as non-living objects outside the cell.

Weight: A measure of the force of attraction of the earth on an object